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REPORT ON THE BORE
OF THE
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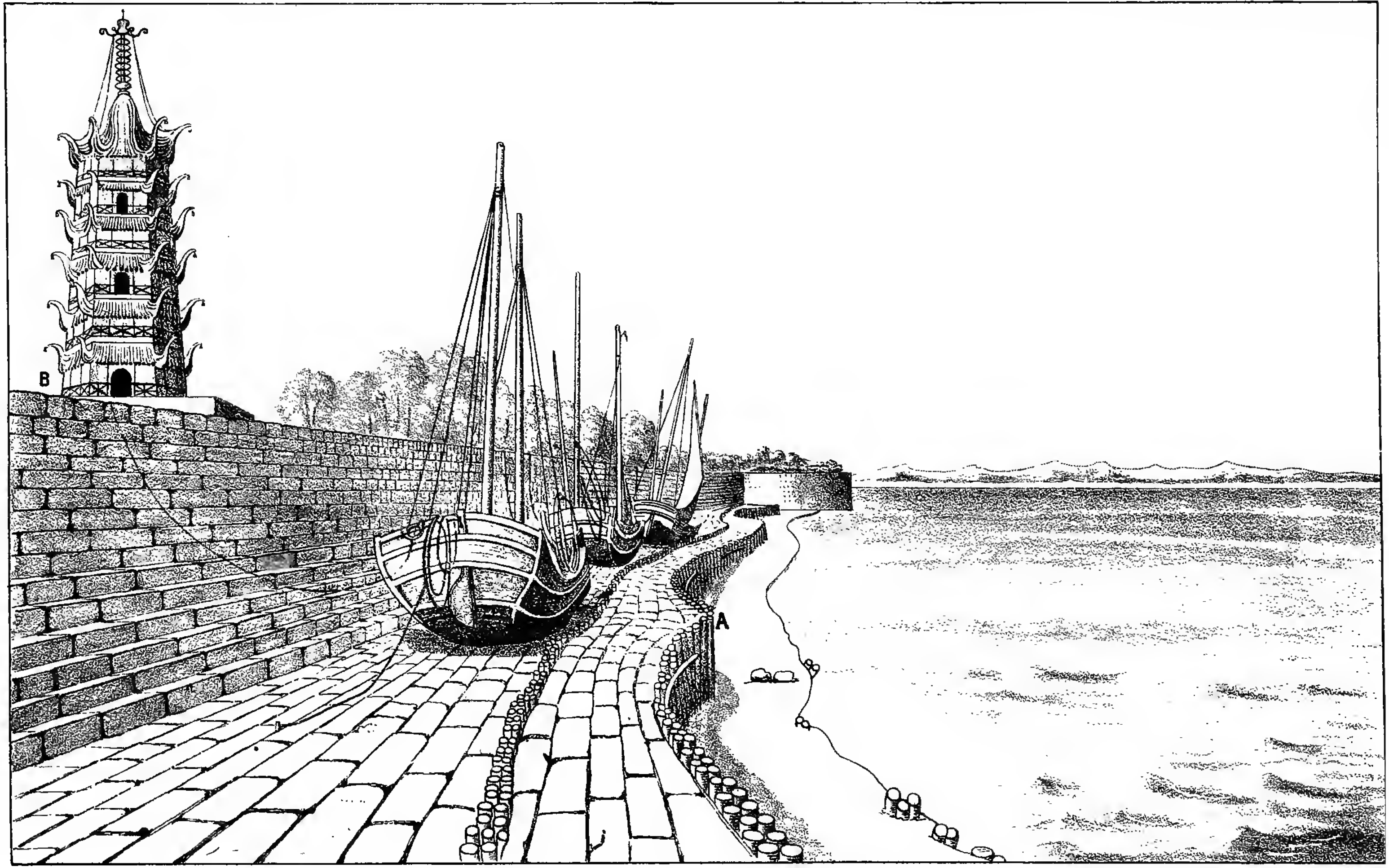

BORE SHELTER FOR JUNKS. AT BHOTA PAGODA HAINING.

REPORT

ON THE

BORE OF THE TSIEN-TANG KIANG,

BY

COMMANDER MOORE, R.N., H.M.S. "RAMBLER."

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CHINA.

REPORT ON THE BORE OF THE TSIEN-TANG KIANG.

H.M.S. " Rambler,"
NINGPO,
5th November 1888.

SIR,

The survey in Chinese waters by H.M.S. " Rambler " approaching its close it seemed a fitting termination to a long series of tidal observations in this region that, before the end of this, the final season, some observations should be made of the Bore of the Tsien-tang.

The published information concerning this special tidal phenomenon is exceedingly meagre, even respecting those rivers where it occurs in the British Islands ; and with regard to this particular instance—the Tsien-tang—scarcely anything is known about it. Although it occurs twice a day throughout the year, 70 miles from Shanghai, and within an easy walk of Hang-chau, the once famous capital of the Empire, now that of the province of Chekiang ; and though the access to the river on which it travels is easy from the Yangtze Kiang, the mere mention of the existence of the phenomenon is all that can be found in published works of either an official or non-official character.*

I therefore considered it would be a legitimate deflection from my surveying duties in the Chusan archipelago, to spend two or three days in the Hang-chau estuary, and endeavour to find out the height, speed, origin, and general character of the Bore of the Tsien-tang-kiang ; and at Full Moon in September, before visiting Shanghai for coal and leave, I proceeded in Her Majesty's ship under my command to a position at the south-west end of Chapu bay. I have, now, the honour to submit an account of our observations and the means by which they were obtained, dividing my remarks into I.—Narrative

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* The latest edition of Webster's Unabridged Dictionary mentions the Bore as one which in reality deserves the name. Where the Author got his information from is a mystery.

S.O. 10833.—200.—1/89. Wt. 19231. D. & S.

of boat expeditions for the purpose of observing the Bore. 2.—Summary of observations, with particulars of height, appearance, and times of passing the observer. III.—Native view of the Bore. Opinion as to the cause of the phenomenon. Review of the observations and general conclusions.

The appendices consist of copies of tide journals, comparisons of differences of level of the sea at certain stations, evidence and proofs as to height and speed, returns of astronomical observations.

On the morning of the 19th September the "Rambler" was moored in 17 fathoms north of an island situated close to the south-west cape of Chapu bay, which was named after the ship, and which proved to be in latitude 30° 26′ 1″ N., and longitude 120° 58′ 4″ E.

This is not a good anchorage; but it was necessary to erect a tide pole on the island to take observations for latitude and longitude and so forth; and no better could be obtained. Navigation west of Rambler island is attended with danger not only on account of the shoal water but the rapid tides and overfalls, especially the first violent rush of the flood, which, though here seldom adopting the distinctive character of a Bore, is of sufficient force to test the strongest ground tackle.* Lieutenant Simpson was directed to obtain the geographical position, and conduct the tidal observations at this station. He succeeded in putting up his pole and starting the record by 9.30 a.m. on the 20th.

At 8.15 on the morning of the 20th September, the steam cutter "Pandora" (in my charge); the sailing cutter "Brunswick" in charge of Lieutenant Purey-Cust, with a reduced crew and party of officers comprising Mr. Dawson, Mr. Beal, and Doctor Bassett Smith; and the steam cutter "Gulnare" in charge of Lieutenant Parry, left the ship with instruments, tide poles, and coal and provisions for a week. The distance to the entrance of the river was about 30 miles; the flood had begun, and I hoped to carry it up behind the Bore (which I believed formed at the mouth of the river) to the city, a distance of about 45 miles. I must here remark that what I call the entrance to the Tsien-tang-kiang, is that part where the coast of the right or south bank trends abruptly to the southward, and where Haining is situated on the north bank. The area east of this will be alluded to as the Hang-chau estuary. Lieutenant Parry was to be left with a tide pole and instruments at the island supposed to exist at the mouth of the river (*see* chart, No 1,262), and another tide pole was to be erected near the city.

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* Page 406 China Sea Directory, Vol. iii., contains the account of an accident to H.M.S. "Flamer" (commanded, I believe, by the present Admiral Bosanquet) from this cause. She was some 2 or 3 miles west of Rambler island.

Six or seven miles west of Rambler island the marks on the rocks indicated a far smaller range of tide than in Chapu bay.

I have no figures to support my statement; but I believe the rise and fall to be higher at the island than at any other point in the estuary.

After passing the islands off the Kanpu (of Marco Polo) we ran into 5 feet. About 9.45 a junk, tacking about inshore, was spoken with. The master of her said there was more water outside than inshore. If we wanted to go up to the city along the shore, we must anchor and wait till the afternoon. He said nothing about the Bore.* On hearing the interpreter's account, I edged out towards the middle of the estuary, getting 4 to 7 feet, the stream still in our favour; and selecting what appeared to be the most likely gap in the mountains answering to the course on the chart for the entrance to the river, steered for it. All went well until 11.30, by which time we must have steamed over the ground 14 or 15 miles in a S.W. by W. direction from Kanpu. Here I touched the ground, and being unable to stop the boat from going on to the bank, let go the anchor. The cable instantly ran out to the clinch and carried away some fittings in the bows, injuring one of the crew, the boat swung violently round as far as the keel would let her; and, signals notwithstanding, the boats astern, being unable to stop their way, rapidly came up to the same spot.

The "Gulnare," casting off the "Brunswick," judiciously kept herself afloat; but the latter fell upon the "Pandora," and bounding off, drove on to the bank, and over it, until brought up by her anchor. To my relief, she was seen riding easily as soon as the tide floated her, her smaller draught affording her a great advantage in not opposing so much resistance as the steam cutters. As soon as the "Pandora" floated, I went full speed ahead, but found it impossible to slacken the cable, and that we were driving rapidly to the north-west with 31 fathoms chain out. Three minature waves passed, fortunately not putting any water in our laden boats. The "Gulnare" finding herself unable to stem the stream also anchored.†

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* Two hours later, when we were driving with anchors down before the after-rush, this junk was seen flying into the river on the back of the Bore. No doubt, he was waiting for the first overfalls to pass by.

† This was the commencement of the southern branch of the Bore. We had started an hour too soon.

We were forced to remain here one hour, the steam cutters gradually dragging past the "Brunswick" to the north-west. By patent log Mr. Parry found the speed of the stream to be 10 to 11 knots an hour, and the water to rise 9 feet in 30 minutes. As I had the dingy astern it was difficult to keep my log clear, but it showed a rate of 9 knots for the first rush, and the tail was revolving against the bilge of the boat astern.

In page 407 China Sea directory, volume 3, there is an account of Captain Collinson's experiences near the same spot—evidently about the same time of tide. He found the speed of the flood to be 11½ knots. His island, Pe-yu-shan, I could not identify; but a line of very low cultivated land was seen to the southward.

At 12.45, the steam having slackened, we were able to weigh the anchors. After consultation with Lieutenant Cust, I steered to the northward, and eventually found the entrance of the Tsien-tang at 4 p.m. It proved to be very low land, and 8 miles in error in latitude.* A junk was observed standing up the river, and it appeared to be the best course to follow her, bearing in mind that she, as well as ourselves, had to find a place of safety before the arrival of the next Bore. As I neared this junk, she put her helm up, and beached on the south bank about 4.15, the tide having now fallen about 6 feet out of 19. I immediately ran ashore as close to her as possible; but drawing three feet to her two, did not reach the same place by 300 or 400 yards. The ebb stream was now making fast, and Lieutenant Parry, with the "Brunswick" in tow, though he made every endeavour to reach me, was unable to do so; and both boats grounded about one third of a mile to the eastward, a deep gutter of swiftly-running water being between us. The junk men, on being consulted, assured me that the four boats were in safe positions; but that care must be observed in laying out the anchors. The Bore would pass along the opposite shore, but the flood stream, after it had passed, would approach the boats from the north-east with some violence.

Later on, when the water had fallen another 6 feet or so, a junk man and the interpreter found their way across to Lieutenant Cust with a letter; and every precaution was taken by that officer and Lieutenant Parry to guard against injury to their boats. The anchors, which weighed 60 lbs., were buried and backed up—in the case of the "Brunswick" by a 30 lb. anchor—in that of the "Gulnare" by 4 sinkers, each weighing ½ cwt. The "Gulnare" had 33 fathoms chain taut, with a 2-cwt. bag of coal on the bight of it, 1½ fathoms from the anchor. The "Brunswick" had 30 fathoms grapnel taut, and two 2-cwt. bags of coal secured to the grapnel near the anchor. In each case the coal bags were secured at the mouth sufficiently, as it was thought, to prevent the contents falling out; and the bottom was tolerable holding ground of sand and mud. The "Pandora's" anchor was buried, and two small weights attached to the bight of the chain. Dingy fast to "Pandora."

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* There is no island off the mouth, as delineated in Chart No. 1,262.

The keels of the "Pandora" and dingy were about 10 to 11 feet above the low line, and those of the "Gulnare" and "Brunswick" between 6 and 8 feet. The distance of the two former boats from the waterway of the river at dead low tide was about three-quarters a mile; that of the two latter about half a mile.

On his return, the junk man who had assisted to lay out the anchors of the two outside boats, informed me, through the interpreter, that all was now secure, and departed to obtain permission from his master to pilot us to the city on the following morning.

It was a calm, still night, with a little rain hanging about, the moon being obscured. The murmur of the Bore in the distance was heard at 11h. 29m.; it could be seen at 11h. 55m., and it passed us with a roar at 12h. 20m. As the Chinese had predicted, it was well over on the opposite shore; and after looking at the light of the "Brunswick" and making my notes, I laid down for half an hour, feeling no concern as to the safety of any of the party. When the water pattered up to the bilge of my own boat, which was not till about one o'clock, I had the bag of coal, which had been placed under the bilges instead of shores, removed from the off side to that where I expected the rush, and made ready to haul in the other immediately the boat floated. Unfortunately the stream, which came when there was only a foot of water over the sand, took us on the wrong bow, and bound the boat up against the still immersed bag of coal, heeling her over to a current running at a speed of at least 8 knots an hour. After one or two struggles, during which she fell over once on the starboard bilge, but not long enough, or steadily enough, to allow of the bag being hauled on board, she floated, and the bag, though closed, as I imagined, sufficiently to prevent coal falling out, was hauled up empty. At 2.15 the sounding was 9 feet, and the stream slack. Before 3 a.m. it was running briskly in the opposite direction.*

The rudder post and propeller guard of the "Pandora" (no doubt wrenched in the morning) having been broken off, and being unable to steer, even with an oar, I was obliged now to beach for repairs. At daylight nothing could be seen of the "Gulnare" and "Brunswick." One native assured me that they were 6 or 7 miles higher up the river, but his statement was not corroborated. The bank on which they had beached was searched, and no signs were found of anchors or cables, or any of the gear. This allayed my apprehension, for if one or both had foundered, at least an anchor and some remains of a boat or fittings would have been left on the sand. It was not, however, until I floated in the afternoon, and steamed up the south bank of the river, that I had the satisfaction of feeling certain all was well. I found the "Gulnare" and "Brunswick" aground about 3 miles from their original position. Lieutenant Purey-Cust's notes on the occurrence are as follow:—"4.15, grounded in "Brunswick," close to "Gulnare," opposite "Haining Pagoda, about a mile from the south shore, on hard sand "and mud (there were several quicksands in the vicinity), the "ripples on the sand were distinctly marked by the flow of the "previous Bore, and the Chinaman who showed us in what direction "to lay our anchors out did so by reference to their direction. "Moonlight, but cloudy; light air from the westward. About "11.30 p.m. a low murmur was first heard to the eastward, which "very gradually increased to a roar as the Bore got close. At "12.10 it could be seen approaching, apparently in the form of a "steep slope of white water overfalling and pouring over itself as it "advanced. Only one wave could be seen, and the river appeared "filled up immediately behind to its full height. At 12.15 the wave "passed us outside in the channel, and at 12.20 the overflow outwards over the flats—from the big wave—struck us at an angle of "45° with the general direction of the river. We experienced no "actual wave, but only a violent rush of water in a succession of big "ripples, the boats shipped no water, only a little spray. In a few "moments the boat was afloat in a current of from 7 to 8 knots (the "direction of the current, both now and after was the same as the "first rush, viz., up river and towards the south bank). In the first "ten minutes the water rose 9 feet, after which the boat began to "drag, and no reliable observations could be taken. A few minutes

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* High water that night proved to be 3.15.

"after a sort of reflex wave was seen coming up rapidly astern, "apparently the rebound from the bank, but simply an undulation, "and nothing dangerous, and there was no alteration in the current. "Twice after the passage of the Bore there were rushes of water, "and increased violence of the stream, accompanied by a few ripples "from the old direction; but no signs of a second or third wave "outside; the last rush was the most violent of all, and the stream "certainly could not have been less than 10 knots at the very least. "At 1.10 the stream slackened, and the boats, which had been dragging in company (although the "Gulnare" had been steaming full "speed all the time) for about 20 to 30 minutes, brought up in 6 feet "about 3 miles from where we started. In a few minutes it was "perfectly slack water. We proceeded in-shore, where a fairly "strong ebb (eddy ?) was running. The "Brunswick" was anchored "with 60-lb. anchor and 30-fathoms grapnel, backed up with a 30-lb. "anchor, two 2-cwt. bags of coal secured to the grapnel near the "anchor. On weighing, the coal, with the exception of about ½ cwt. "in one bag, was found to have all washed out; and its place taken by "hard sand, tightly packed into the bags; the pea of the anchor was "like polished silver from the friction in dragging."

From Lieutenant Parry, I learn that the "Gulnare" had a bad time of it. She floated almost immediately the water touched her keel, and then made a bound over to port, bringing a severe strain on cable and fittings, and heeling over until the wash cloth was nearly in the water. She then commenced to drive to the westward, past the "Brunswick," which boat, however, followed in a few minutes, and kept pace with her. When hove up, the pea of the anchor and the greater part of the chain were as bright as polished silver.*

It has been necessary to trouble you with these details in order to show the after effects of the Bore on three boats apparently in safety, and the nearest of which cannot have been less than half-a-mile from it, and 6½ to 7 feet above its foot. The reason of this sluice which follows the first crested onset of the flood, I shall be able to show under heading III. when discussing the records of tide and comparisons of levels.

The uneveness of the surface of the flood was an extraordinary feature in this night's observations. Lieutenant Cust obtained a sounding of 9 feet before the water reached my boat; and yet he grounded in the afternoon before my cutter was dry. Allowing for a slight error in the sounding due to an 8-knot stream, and for both his time and mine to be only approximate after Bore had passed, yet it was certain that he dragged past me with plenty of water under him some minutes before the water reached me ; and consequently the river must have been out of level—so to speak—at least 3 or 4 feet for a quarter of an hour. The fissure between the banks may have had something to do with this.

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* Those who have had practical experience of the effect of a tumultuous current of great velocity will recognise the skill which brought these three small boats out of their dangerous situation with so little damage.—W. J. L. W.

The Bore of 21st September midday passed the Pagoda at Haining at 12.47, and being enhanced by mirage, presented a fine spectacle. At 4 p.m. I joined Lieutenant Cust and secured in a safe position 3 miles west of the berth of the previous night and 1½ miles from the low line of the river abreast. The night Bore was heard at 12.20 ; it passed Haining at 12.52 and the boats at 1h. 5m. It was too far off to enable me to make any notes of its height and appearance.

Lieutenant Cust had secured a pilot who agreed to take us to the city ; but the "Brunswick" did not float until 4 a.m., an hour later than was expected, and then only by removing all her stores. We found to our disappointment that Springs were passed. On cross examining the pilot, it turned out that the navigation to Hang-chau left no safe margin for delays ; and I had to remember that if the steam cutters took the ground after 5 o'clock, there was only one course—to remove as much gear as we could, and if a sufficient number of men could not be obtained to carry them, to abandon the boats * to the mercy of the mid-day Bore. Nearly all our coal was gone. Wood could only be purchased with difficulty. The many miles of sand flats between the river and the ship, and the knowledge now in my possession that the Bore originated about 12 or 14 miles outside, almost as near, in fact, to the "Rambler" as to the river, demanded the greatest caution in returning after Springs.

Under these circumstances, I did not feel justified in going on to the city, or even remaining in the river with the boats (one of the cutters being seriously damaged), and reluctantly decided to return to the "Rambler."

The pilot was therefore questioned and undertook to navigate the boats to Chapu bay.

One instance will show the difficulty of navigation in this river, even for small boats. As you are aware our steam cutters can count upon a speed of 5 knots an hour. I wanted to go over to Haining at 4 o'clock to arrange for landing Mr. Parry and for the conveyance of

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* I have since found out there are several junk platforms along the sea wall ; but the pilot at the time declared that there were none.

the officers to Hang-chau, but was unable to do so for this reason. The distance was 3 miles. Time, high water. It would take half-an-hour to go over, perhaps less; say we stopped half-an-hour; the return would have occupied at least 2 hours, as the out-going stream would be running 5 or 6 knots in the channel. This would bring us back by 8 o'clock, and at that time it was not possible anywhere, up or down, or on either bank of the river, to secure a steam cutter clear of the Bore.

During the forenoon of the 22nd a base of 7789 feet was measured on the South bank, and the speed of the mid-day Bore observed. It proved to be 12·7 knots an hour. The height was also ascertained and the range of ordinary springs measured and found to be 19½ feet. Lieutenant Cust, Mr. Dawson and Doctor Bassett-Smith procured a junk to cross the river to Haining after the Bore passed; and from Haining they proceeded in the rear of the night Bore to Hang-chau, eventually joining the "Rambler" at Shanghai. At high water I started, with Mr. Parry, on our return journey. The best channel is along the north shore of the estuary, and the distance 29 miles. After 4 p.m. a strong ebb stream set out; but the pilot would not take the boats on after dark, but secured them in a bay under Chi-san cape, 12 miles east of Haining, giving out that he would not move in the morning if there was any wind.

In this bay which I have named "Bore Shelter bay," and which is protected to the south by a long rocky point with a small pagoda or beacon at the end of it, the Bore is not felt; but during the first watch we could hear continual overfalls outside of us, and the water where we were grounding our boats rose and fell incessantly for 2 hours as much as 3 feet in the most singular manner, without any surface disturbance, showing the struggle in progress between the outgoing stream and the first of the flood. At 4 a.m. on the 23rd, it was calm, and we resumed our journey, reaching the "Rambler" at 6 o'clock.

Lieutenant Balfour reported to me that there had been a very severe strain on the cables with the first of the ebb; that it had been found necessary to shift one shackle, a link being bent; and that the day Bore of the 21st had commenced to form to seaward of the anchorage and had passed the ship in the form of an overfall of sufficient height to throw water into the mizen chains. It was evident that the stay of the ship should be shortened as much as possible. On the next morning—Monday—the tide party was removed from Rambler island and the vessel was unmoored; not however, before another shackle had been rendered useless. A north-east wind, of moderate strength, set in with the first of the flood, and a severe tide rippling surrounded the ship throwing water on to the poop. I endeavoured to weigh and get to sea; but in an unlucky moment a swift rush came round an island on the bow, suddenly bringing a strain on the cable at short stay. The pauls of the capstan and all the capstan bars, except two, carried away, and two men were injured, not, I am glad to say—as it turned out—very seriously. We then commenced to drag; and had to veer and prepare to slip. Steam being ready at a high pressure, I held on as long as possible, and was enabled at last, when the stream slackened, to raise the anchor.

This overfall lasted two hours, the water rising on Rambler island in a manner visible to the eye from the deck of the ship, and attaining a greater height 2 hours before high water than its maximum of previous days.

At 4 p.m. we passed Chapu, reached West Volcano island at 8.30 p.m., removed the tide party, and proceeded to Shanghai on the following day.

Our excursion to the Tsien-tang dispelled two illusions under which I had been labouring. Of course one does not visit an estuary of the shape of the Hang-chau gulf without anticipating very strong tides, and preparing for them; but it was entirely contrary to our previous experience to find these 8 to 11 knot streams running over sand only just covered with water. I imagined that they were confined to the channels. Moreover, I was under the impression that Bores in general, and that of the Tsien-tang in particular, originated at the mouth, or inside the mouth, of the rivers which they traverse, and not 12 to 15 miles outside of it.

Steam cutters, drawing as they do, 3 feet, and offering so much resistance to the water, prove to be unsuitable boats for the navigation of this river. The 10-knot rush comes when there is from one to 2 feet water over the sand flats, and then there is a violent struggle to get afloat, unless the level of the crest of the Bore happens to be above the level required to float the boat, in which case they are lifted at once. The junks found in the river or the estuary draw 1½ to 2 feet, and their bottoms are quite flat. They drive a pole through a hole in the fore part of the boat, and hammer it down into the sand, keeping their anchors ready to hold them directly they are water borne. The shape of the sloping prow and their build altogether causes them to rise lightly over a great surface rush of water.

Our opportunities of seeing the Bore had been so far good ; but some questions respecting the phenomenon still remained unanswered ; and it was necessary to ascertain the geographical positions of Hang-chau and of the mouth of the river. I therefore engaged a house boat, and at daybreak on 30th September, started up the Wusung river, taking with me an interpreter, three Chinese servants, two chronometers, and the necessary instruments for sun observations. Mr. Grant, of Messrs. Boyd & Co.'s building yard, kindly directed one of his launches to tow me 60 miles on the journey, our own steamboats being under repair. Owing to this lift the walled town of Ka-sei was passed at 5 p.m., and Kua-shing on the Grand Canal at midnight ; Sak-mun-sing a few hours later. Part of the journey on the Grand Canal was made by tracking, part by sailing. At 2.30 a.m. on 2nd October, the boat was stopped at the outer canal gates of Hang-chau. The gates were open at 6 a.m. and we arrived at the jetty half an hour later. The entire journey is about 110 miles.

After a walk of over 4 miles, I reached the Bishop's house, Ma-sao-yang, which is situated slightly to the north-east of the centre of the city, and during the day, equal altitudes of the sun were observed for longitude and circum-meridian altitude sun for latitude. The ground is very tremulous, which is not to be wondered at considering that there are 500,000 people around, the majority of whom are walking about all day. I cannot rely upon either the latitude or longitude of Ma-sao-yang to 15″. On the following day, after an interview with the Bishop of Mid-China, who arrived in the morning from a confirmation tour, I proceeded to Haining.

Owing to the kind offices of Dr. Main, the missionary, the Louta of my house boat had been induced to bring her over a pao into the city ; and I was enabled to proceed on the higher level instead of going back and branching off from the Grand Canal which would have made the meridian distance to Haining one day longer. The direct distance between Ma-sao-yang and Bhota pagoda Haining is 20·7 miles ; by canal about 30 miles ; and the journey occupied 29 hours, the crew sculling in watches of three each. We arrived at Haining at 8.30 a.m., on the 4th October, and at once proceeded to the Bhota pagoda, which is 1½ miles from where the boat secured. Satisfactory equal altitudes of the sun for longitude, and circum-meridian altitudes sun for latitude were obtained during the day, and the mid-day Bore observed. The natives were excessively curious. If the Siamese twins had appeared on the scene, and commenced to take sights with two sextants and artificial horizons, they could not have excited more wonder; and yet these people must soon have discovered that I had the same complement of arms and legs as themselves.

They were, however, not offensive. All they wanted was to gaze at and, if possible, touch the foreign devil. They formed themselves into a comet-shaped mass, and when asked to keep quiet while I listened to the beats of the chronometer, remained silent for twenty minutes.

Later on in the day, I found that a cordon of spunyarn, held by my Chinese servants, was sufficient to keep off the crowd. Some of the men remained staring all day, going away to get their chow and returning to the barrier.

From Haining, notes were made of six Bores about the New Moon. Bad weather set in on the 6th October, and after the mid-day Bore of the 7th, I returned to the "Rambler" at Shanghai, descending to the lower level by a pao some 4 miles west of Haining, and entering the Grand Canal at Sak-mun-sing.

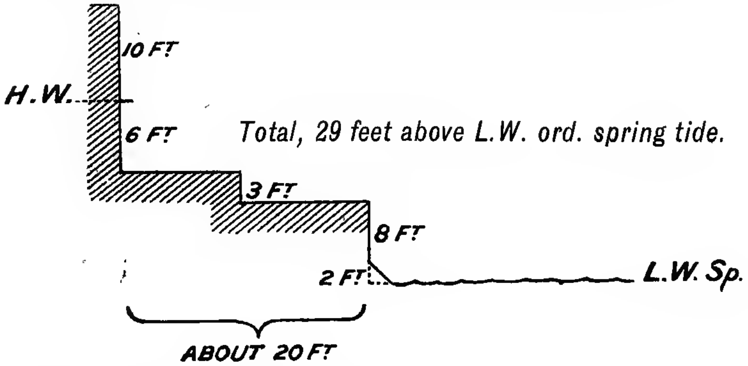
The "Rambler" was reached at 11.30 p.m., 9th October. The distance direct is about 70 miles, and I believe there is a way of going which is nearly straight; by the route we took it must have been nearly 90 miles.

Satisfactory equal altitudes of the sun were obtained on the 10th for the errors of chronometers.

This gave a passage rate of 11 days. The meridian distances are shown in Appendix E.

A few observations are necessary respecting Haining, in order to show you the manner by which the height of Bores was obtained. As before remarked, this town is at the mouth of the Tsien-tang-kiang, on the north or left bank. The Bhota Pagoda, built ages ago to solicit a good Fungshui to keep out the flood, is the most favourable point of view from which to see the Bore approach, and from which to watch it enter the river as a whole after the junction of its two branches, and its conflict with the sea wall. It is here, that it is first seen as one unbroken compact cascade, and where it commences its majestic progress in one ridge towards the city. From Haining there is a busy export of rice, bean cake, cloth, charcoal, cotton, and bamboo paper. Samshu spirit, salt, and fish are brought to it. The junks, of which sometimes a dozen may be seen loading or unloading at the same time, draw from 1½ to 2 feet, empty, and ground $1\frac{1}{2}$ hours to 2 hours after high-water on a platform of stones inclosed by piles alongside the sea wall. The attached sketch will best show how this platform is constructed, and how it is protected from the Bore by a massive buttress at the eastern end 253 feet long (*i.e.* parallel to the sea wall) and 66 feet wide, which is semi-elliptical in shape; and deflects the flood stream before it reaches the shelter. From the estuary south-east of Haining, the junk platform is protected by a spit of sand, dry at low water, round which the southern branch of the flood must pass. Unless, therefore, the buttress is destroyed, or the south bank of the river changes its shape, the force of the Bore cannot be experienced by a junk on the platform, though the side of the cascade will wash along the piles which confine the stones.

This shelter, abreast the Pagoda, is 1,100 yards long, 20 feet wide, and 7 to 8 feet above low water ordinary spring tide. At the west end of it, there is another buttress protecting a shelter on a higher level, of which Mr. Cust made the following measurements:—

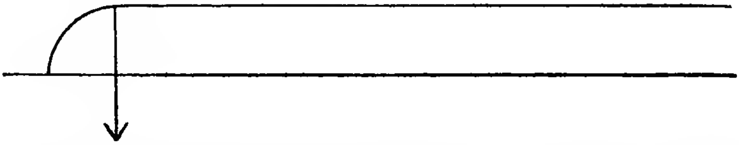


The shelters, and I understand that there are others up the river, are well inside of a direct line from buttress to buttress.

The sea wall, abreast the Pagoda, is $23\frac{1}{2}$ feet high above low water ordinary spring tide, and 16 feet above the junk platform. The side is cut in steps (15) like those of a dock, but only 4 inches broad; so that the side of a junk rising and falling does not lodge. They may strike the wall, and in fact often do, when the spring tide Bores pass, but rudely built as they are, no harm comes of it. When the Bore is heard approaching, the junk master looks to his warps, lays out extra ropes if he thinks it will be a high cascade, and summonses his crew, who stand by with poles and boat-hooks. When the after-wash has passed and he is fairly afloat, he is able to carry on with his loading.

The water must be 9 feet high to float an empty junk. For the reasons I have mentioned, and because the bank, though steep-to from the channel of the river, is actually dry for 3 or 4 feet outside the piles which confine the junk platform ; the side of the Bore is never so high as the crest over the deep water. Thus, if at the first rush I observe that the piles are hidden and the junks afloat, as was the case on Sunday, 7th October, and it is plain that the crest of the cascade is 2 or 3 feet higher than the side of it, I report, with confidence, the height of the Bore as 10 to 11 feet.

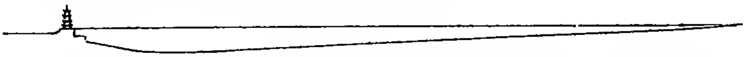
The term Bore as meant in this letter is the crest of the cascade in front of the advancing flood, that part where the wàter commences to fall over the edge of the plane on to the river beneath.



The water invariably rises, within fifteen minutes after the passage of the Bore, to a height above it of from one quarter to one half its own height. This is not, strictly speaking, the Bore, and is not included. Again, the surface behind the crest is generally in a state of violent commotion, the waves leaping up many feet above the general level. The height of these waves is not taken into account in recording the measurement of the Bore.

The attached sketch chart will show the lay of the land and the position of the place of observation with reference to the estuary and opposite side of the river. The Tsien-tang, opposite the Pagoda, is 2·4 miles wide, but at low water the breadth of the stream is 0·97.

The deepest water is some 2 to 4 cables from the north bank, the section being somewhat like this in shape.



From the statements of the natives and one or two casual soundings, I have reason to believe that there are 2 to 3 fathoms, at least, in the channel, at low water springs. One sounding of 7½ fathoms was obtained at high water.

The sea wall affords some evidence of the force of the Bore, and its construction shows what the authorities have thought necessary to oppose it. As it is distinguished by the Chinese from the embankment behind, it was probably built at a different epoch. Both are very old. The two together measure across 80 to 90 feet, of which the sea wall occupies 30 feet. Its top* is 3 to 4 feet above high water ordinary spring tide, and is faced with blocks of stone 5 feet long, 16 inches broad, and 14 inches deep, laid end ways out, and joined together by rivets of iron. Thirty to forty feet inside, on the embankment, there is a mud ridge, 7 to 8 feet high, lined with trees. Beyond the sea wall are the junk shelters and buttresses before described ; the latter are of mud, faced with fascines.

The sea wall, as distinguished from the embankment behind it, is said to have been built over 500 years. It extends, without interruption, to Chi-san eastward, and up the river some 14 or 15 miles, a total distance of some 26 miles. About 1,000 people are said to be constantly employed on its repair. I have only seen 12 miles of it (that near the Pagoda, and to Bore Shelter bay under Chi-san); but that portion was in excellent condition. The country which it protects is 2 to 6 feet below high water springs.

The embankment extends with more or less regularity from the Tsien-tang-kiang to Wusung round the Yangtze cape, a distance of 120 miles.

The Bhota pagoda at Haining, which is said to be over a thousand years old, is 120 feet high, hexagonal, six storied, and has 36 bells. The highest gallery is 84 feet above high water, and consequently 103 feet above the level of the river before the Bore arrives. The outer wall round the bottom of the Pagoda is distant 30 feet from the edge of the sea wall.

II. Record of the observations of various Bores about Full Moon, September, and New Moon, October 1888.

To render this branch of my report intelligible, I beg to draw your attention to the copy of the Tide Journal at Rambler island about Full Moon, Appendix B. You will observe that about one hour after low water there is always a sudden rise of 10 to 12 feet in an hour. This evidently is the birth of the Bore, but as the vast fields of sand dry, or nearly dry, at low water springs are situated to the westward of this station, it seldom adopts the distinctive character—that is, there is no actual travelling cascade—until this quick rise is transferred some miles nearer the river. It is worthy of notice, that the number of feet in the jump of one hour corresponds with the height of a spring tide Bore at Haining; and is five times as great as the rise of water at West Volcano island during the same interval.

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* *I.e.*, abreast the Pagoda. West of the Pagoda, half a mile, there are places where it is 9 to 10 feet above high water.

FULL MOON.

20 September Day Bore.

On 20 September, no remarkable overfall was noticed on board the ship, moored N. ¾ E. 4½ cables from the summit of Rambler island; but the water on the pole at the island rose suddenly from 8 feet 3 inches below the mean level at IX. 30 a.m, to 5 feet 11 inches above mean level at XI. 0. The boats of the "Rambler," being at that time S.E. by S., 12 to 13 miles from the entrance to the Tsien-tang-kiang, experienced a violent rush of water to the N.W. at the rate of 10 knots an hour, at XI. 30, with miniature rippling and rise of water 9 feet in 30 minutes. The boats were 8 or 9 miles south of the proper channel to the river, and therefore did not encounter the main Bore.

20 September Night Bore.

About X. 0 p.m. overfalls were first noticed on board the "Rambler;" and the water rose rapidly on the pole from 8 feet 10 inches below mean level at IX. 30 to 5 feet 9 inches above mean level at XI. 0. The boats were aground at mean level on the south bank of the entrance to the Tsien-tang-kiang, and first heard the muttering of the Bore at XI. 20. XII. 20.—Bore passed Pagoda with a loud roar.

This was probably the highest Bore of that moon, as the water rose to 19 feet 6 inches above low water ordinary springs, and did not attain that level on the succeeding days or nights. The moon being obscured no proper estimation could be made, by eye, of its height, nor could any very accurate description be given of its appearance. Natives stated the next morning that it was not a high Bore; but as a boat 7 to 8 feet above its foot obtained a sounding of 9 feet 15 minutes after it had passed, there is reason to suppose that the crest of the cascade could not have been less than 10 to 11 feet in height.

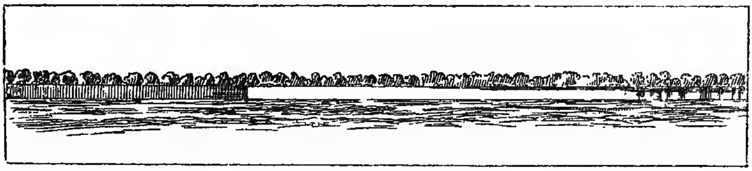
The sea in the estuary and river was calm. Light north-westerly wind with occasional fine rain. It was high water about III. 15. At III. 0 the current was running out strong along the south bank.

21 September Day Bore.

On 21st September about IX. 45 a.m., an overfall was seen by Lieutenant Balfour approaching the ship from a distance of 4 to 5 miles in the offing to the north-east.

It reached the ship at X. 15, the waves being sufficiently high when breaking against the broadside to throw water into the mizen chains, and spray on to the poop, and then disappeared to the westward past Rambler island. At X. 0 the water commenced to rise rapidly at the island from 9 feet 4 inches below mean level to 4 feet 7 inches above mean level at XI. 0 clock.

From a boat beached at high water on the south bank of the entrance of the Tsien-tang-kiang, the Bore was seen approaching along the sea wall between Haining and Chi-san at XI. 24. It had this appearance :—



Shortly after it was first seen, the white light on the sea wall shot suddenly out to the right to nearly twice its length ; the left extreme always remaining the highest. No doubt this elongation was the junction of the south-east branch of the flood. Weather calm. A good deal of mirage. The appearance, on a closer approach, was that of a long crested wave, breaking in places, in others only about to break, the top of the front of the flood curving towards us and drawing back—hurried on by the speed of the Bore.

XII. 47.—Bore passed Pagoda. Front part a white cascade of foaming water. The south side of the Bore consisted of a long line of breakers and wall of water, tapering from the front to the smooth following water half a mile behind, the breakers discharging outwards towards the south bank of the river. There was broken water on top of the bore for a long distance behind the crest, in which no whale boat could have lived ; and conspicuous above the disturbed water a second roller or miniature Bore rose up occasionally, and after moving onwards with the rest for a time, would leap up as if struck by some unseen force, and disappear in a cloud of spray. Height of Bore 9 feet ; but the broken water behind it could not have been less than 13 or 14 feet above the level of the river in front of the Bore. The Chinese standing by said this was not a high Bore, the weather being calm.

Nine junks came up behind with sail set, but regardless of wind, of which, indeed, there was none, and entered the river at a great speed.

A feature of this Bore worth noticing was the deliberation of the curved side in breaking. This is only seen at the mouth of the river, from the south bank. All the front and over to the north shore is a continuous cascade.

It is the outer discharge on to the very gradual sand slope which shows as deliberate breakers, and in any sense as a "wall." It looked, at times, as if the great speed checked the curve just as it was about to make its arch over on to the sand.

At I. 38 water had risen 15 feet (approx.). High water between III. and III. 30. The stream was then making out strong along the south bank.

21 September Night Bore. The water rose at Rambler island from 10 feet 7 inches below mean level at X. 0 p.m. to 4 feet 9 inches above mean level at XI. 30.

Boats beached on the south bank 3 miles west of Haining.

XII. 20.—Heard the Bore approaching.

XII. 52.—Bore passed Pagoda.

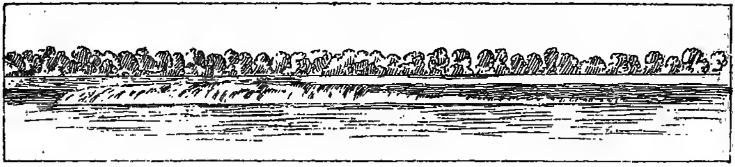
I. 5.—Bore passed the boats too far off to make any observation of its height or appearance.

It was high water about III. 30 a.m., and the stream was then running out along the south bank.

22 September Day Bore. At XI. 0 a.m on 22nd September overfalls surrounded the Rambler. The water rose rapidly at the island from 11 feet 8 inches below mean level at X. 0 to 3 feet above mean level at XI. 30. The Bore was sighted by an observer standing 5 feet above high water springs, at XII. 55, and the murmur was heard about the same time.

I. 10 p.m—Bore passed Pagoda.

I. 22.—It passed theodolite of observer. Appearance thus :—



The speed was ascertained to be 12·7 knots an hour, and height 10 to 11 feet.

No second wave was seen on this or on any other day.

As on the 21st, the south side of the Bore formed a line of breakers, and water attempting to break, tapering in height from the crest of the cascade in front to the smooth shining flood following. Disturbance on the back of the Bore; but not so marked as on the 21st. The river filled up to the level of the Bore very quickly after the cascade passed.

High water at IV. 0 p.m., and stream soon began to set out.

On the south bank, stream setting out at II. 45.

22 September Night Bore.

The officers in the ships' boats were not in a position to make any observations of this Bore.

At XI. 0 p.m overfalls surrounded the Rambler. The water rose on the pole at Rambler island from 9 feet 4 inches below mean level at X. 30 to 5 feet 11 inches above mean level at midnight.

At I. 20 a.m. (approx.) Bore passed Pagoda. Height 8 to 10 feet.

It was observed at Haining that at VIII. 20 p.m., the water had fallen to 5 feet above its lowest, having dropped 13 feet 4 inches in four hours.

The river was at its lowest immediately before the Bore arrived, and the stream was running out. There was only one wave, its front boiling and curling over itself. At II. 0 a.m. the water had risen 15 feet.

23 September Day Bore.

On the 23rd September there was a rapid rise of water at Rambler island from 11 feet 10 inches below mean level at X. 30 to 5 feet 9 inches above mean level at XII. 30. The Bore passed the ferry at the city of Hang-chau, 52 miles distant from Rambler island, at IV. 0 p.m. (approx.). Doctor Bassett-Smith, who watched it, states that the distance he was from the other side of the river was too great to enable him to form a correct estimate of its height; but the larger junks appeared to ride over it; and judging by the after rise of water, the crest of the cascade could not have exceeded 4 to 5 feet.

Abreast the city, the deep channel is off the south bank of the Tsien-tang, and consequently an observer on the north bank, from which the slope is gradual, would have the same view of "lagging" which we had from the south bank of the mouth of the river on the 21st and 22nd. Dr. Bassett-Smith informs me that he first saw the Bore about III. 30 coming up the river as a straight line of foam. As the highest part progressed along the south bank, the flood discharged itself towards him in a very long line of breakers, tapering from the crest to the smooth water in the rear where the river was becoming satisfied. A junk was seen sailing up to the vanishing end of these breakers. When close to she lowered her sail and rode gently over, proceeding on her course down the river. A quarter of an hour after the front of the Bore had passed up, he felt the effect of the discharge of the breakers on the north shore in the form of chow water. Between the time the front of the Bore passed and the arrival of this chow water the water rose quietly 1½ feet. With the chow, it rose 2 feet more; and during the succeeding hour it only rose one foot. The centre range of tide (3 days after full moon) was probably not more than 5 to 6 feet.

It was examination time at Hang-chau; and thousands of students and others flocked down to the water's edge, to witness the phenomenon.

NEW MOON.

4 October Day Bore. Observer on the sea wall abreast Bhota Pagoda, Haining. Day calm.

X. 44.—Bore was seen approaching from a direction between Chi-san and the sea wall.

XI. 2.—A second roller formed behind the first line of breakers, probably due to the effect of the rebound from the sea wall.

XI. 10.—As the flood narrowed in width to enter the mouth of the river, sea very confused; picturesque lines of corkscrew breakers forming and exhausting themselves against the south bank.

XI. 16.—Bore passed Pagoda as one straight line of continuous cascade 5 to 6 feet high, washing the top of the piles confining junk shelter. The line was as straight as infantry on the march for 9 cables. If not for the speed at which it was travelling, I think a well-found launch might have ridden over this Bore. No second wave.

XI. 29.—Water 9 feet.

XII. 28.—Water 14 feet.

I. 53 p.m.—High water, 15 feet above the lowest of the day. Up to the time the Bore passed, the stream was running out in the deep channel of the river.

5 October Day Bore. Observer, first, on highest gallery of Pagoda, 103 feet above low water.

X. 56.—Bore in sight through the telescope of a Troughton and Simms' 6-inch theodolite, coming towards the river along the sea wall. Could distinguish crest curling and breaking in places, in some parts a compact wall. Descended Pagoda and took up position at level of river. Water at its lowest.

XI. 32.—Bore in sight. Height of eye above river 5½ feet.

XI. 50.—Bore passed the Pagoda. Height over deep channel of river 8 feet. Line of cascade nearly straight across and continuous

XI. 58.—Water had risen 10 feet.

I. 43.—Water 16 feet.

II. 50.—High water, 16½ feet.

The water remained at its lowest, and the stream was running out in the deep channel up to the time the Bore arrived. When about 2 miles east of the Pagoda, the flood stream struck the sea wall with great violence, and rebounded. There was a severe tide rippling on the back of the Bore when it passed Pagoda, but no second roller.

Mr. George Moule had stationed himself, at my request, on the sea wall about 5 miles from Hang-chau, and 15 from Haining. The Bore passed him at I. 0 p.m., and the height was 5 feet.

5 October
Night Bore

Observer sitting on the piles which confine the junk shelter under the Pagoda. Night fine and calm.

X. 37.—Heard the muttering of the Bore. I have no doubt I could have heard it before, had it not been for the continuous noisy rippling of the outgoing stream in the deep channel. At this time the flood must have been between 12 and 16 miles distant. X. 45.—Noise very distinct.

XI. 28.—Junk men on top of sea wall stated that they could see the Bore.

XI. 58.—Bore passed Pagoda with a loud roar. First rush level with bottom of sea wall, inner edge of platform. Height in centre 9 feet.

XII. 1.—Junks afloat and surging against wall.

XII. 9.—Water had risen to 13 feet. Highest during the night 18 feet

As far as could be made out in the darkness, the line of cascade was straight across to opposite sands. Water at its lowest when the Bore arrived.

Natives said that, considering the calm weather, this was a high Bore.

6 October
Day Bore

Observer on highest gallery of Pagoda. Weather fine, sea calm. Light airs from south.

XI. 30.—Sighted Bore, coming as usual, straight from inside Chi-san cape, along the sea wall, the highest part being near the sea wall.

N.B.—The dry sand flats visible from the Pagoda, 5 to 10 miles distant in line with Chi-san, no doubt prevent the Bore being seen sooner.

XI. 57.—A second Bore, not quite so high, was observed approaching from the south-east, with a second roller coming up behind it. The latter, on getting nearer subsided and the second Bore presented a uniform appearance.

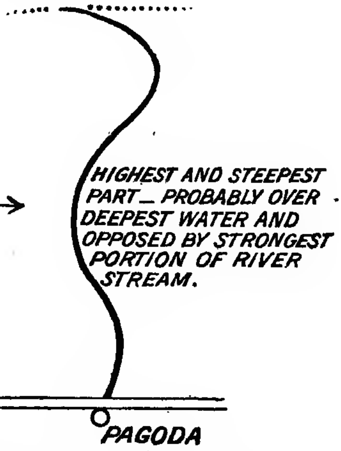
Converging towards each other, the right extreme of the line of breakers extending southward from the sea wall (the main Bore) and the left extreme of the second Bore met at XII. 8 with a splash and overlapping roller.

The combined line of rollers now extended from the sea wall to the sand flats which stretch into the estuary from the south bank of the river, a distance of two miles, subtending an angle of 39°. Noise distinct.

XII. 15.—Flood stream hit the sea wall about 2 miles east of Pagoda, and rebounded with great violence, raising a series of breakers behind but twice as high again as the front of the Bore. These waves and breakers ran for some distance in a southerly direction, the sea of the estuary becoming violently agitated for two miles, and after a time settling down to the mean height of the top of the advancing flood. As the Bore contracted in width to conform to the mouth of the river, the rippling on its back was very severe. The highest part was in the middle, where the opposing rebounds from the sides, met. The water was at its lowest and the stream in the river was running out until the last minute.

XII. 23.—The Bore, now marshalled into a fairly straight line of cascade, entirely breaking in a steep slope of bubbling foam, passed the Pagoda with the usual loud noise.

The line of the cascade was → somewhat in this shape.


HIGHEST AND STEEPEST PART— PROBABLY OVER DEEPEST WATER AND OPPOSED BY STRONGEST PORTION OF RIVER STREAM.
PAGODA

The junks moved at once. Height in centre, over the deep channel 9 feet. A severe rippling was travelling on the back of the Bore, but no second roller.

XII. 29.—Rippling had passed, having extended behind the cascade for about one mile. Eleven junks came up behind the Bore and swept into the river with the after rush.

XII. 40.—Water risen to 14 feet.

III. 19.—High water 19 feet. Stream commenced to set out of the river.

Mr. George Moule observed this Bore from the same place on the sea wall as on 5th October. It passed him at 1 hour 27 minutes. Height 8 feet. Distance from Pagoda 14 to 15 miles.

Observer on the sea wall near Bhota Pagoda. Weather rainy with moderate S.E. wind. 6 October Night Bore.

XI. 38.—Heard the muttering of the Bore. The splash of the waves below prevented its being heard before.

XI. 59.—Noise distinct.

XII. 3.—Occasionally saw the glint of the foam.

XII. 35.—Bore passed Pagoda with a loud roar. Height 10 feet. It appeared to be nearly a straight line across the river.

XII. 42.—Water had risen to 13 feet. The water rose during the night to 19½ feet above low water ordinary springs—4 feet from the top of the sea wall abreast the Pagoda.

Observer on sea wall near Bhota Pagoda, Haining. Wind from eastward, force 4 to 5, with rain and squally appearance to seaward. 7 October Day Bore.

XII. 36.—Heard the Bore. Too much rain to see far.

XII. 40.—Noise distinct though there was talking going on around and sound from the lapping of waves on the sand below.

XII. 48.—Saw the Bore. When between one and two miles east of the Pagoda, the flood stream charged the sea wall and rebounded with great violence, raising an irregular wall of water behind, but about twice as high again as the cascade in front of the Bore. The top of this mass must have been nearly, if not quite, as high as the level of my eye, which was 28 feet above the level of the river at the time. Nothing could be seen beyond it, and at first I took it to be a part of the distant land. At a cautious calculation, I estimate it to have been, for a period of three or four minutes, 20 feet above the level of the river at the same spot immediately before the Bore arrived. Before reaching the entrance of the river it broke and joined the middle of the top of the flood.

XII. 57.—The Bore passed with a loud roar, as one continuous cascade from bank to bank, and instantly floated the junks on the shelter. Over the channel, the crest of the cascade was 10 to 11 feet high; but there was many waves carried along in the rip on its back which were 3 or 4 feet higher. For several minutes after it had passed, the bosom of the flood was violently convulsed, heaving to and fro, from one bank to the other like the surface of the ocean after it has closed over a sinking vessel, now and then leaving a depression in the centre and washing up to within 6 feet of the top of the sea wall.

I. 7.—Mean level of water at the wall 13 feet above low water ordinary springs and the level of the river before the Bore arrived.

The water was at its lowest, and the stream was running out to the last moment.

That portion of the cascade which was over the channel of the river was slightly retarded, and steeper than the rest of the line. The natives said this was a good Bore and attributed its violence to the easterly wind in the estuary.

Judging by the replies I received from the natives to questions at various times, it would appear that none of the Bores we saw were in their estimation, as high as they often are at spring tides.

They expect highest tides and highest Bores in the winter. This is at Haining where a high or low Bore has a practical bearing upon their daily life. At Hang-chau there is a story that the highest Bore is always on the 18th day of the 8th Moon, *i.e.*, 3 days after the Full Moon of September; but it certainly was not so this year, and I cannot see why it should be any year except when Full Moon happens to correspond with Perigee (which it did nearly, 1887).

The junk men say that the water has been known to rise within 2 feet of the top of the sea wall, and to fall 2 feet lower than the lowest I saw. This would make the range of exceptional spring tides 23 feet.

With reference to our Full Moon observations, it should be remarked that the range of that spring tide at West Volcano island was a foot less than it has been, and two feet less than what may be expected under extraordinary conditions; while the water marks on the rocks around Rambler island and opposite coast indicated a possible tide 17 feet above our computed mean level, and 5 feet above the spring high water which we recorded. The New Moon Bores were not assisted by any continuous easterly wind in the gulf, though a wind sprung up during the last 24 hours of my stay and no doubt made the Night Bore of the 6th October and the Day Bore of 7th both higher and earlier than they otherwise would have been. I believe the phenomenon has been observed under normal conditions, possibly under rather less favourable circumstances than usual.

Undoubtedly there are occasions when the crest of the cascade attains a height of 15 feet and continues at that height for a distance of 16 miles. A typhoon or a long continuance of easterly wind blowing into the gulf would occasion this.

I will now compare the times of the passage of the Bore with that of the transit of the moon succeeding that to which the origin of the phenomenon is due.

Date.	A.M. or P.M.	Mean Time Bore passed Pagoda, Haining.	Time of Moon's Transit.	Bore passed before or after.	Interval between Bore passing and Transit of Moon.
		H. M.	H. M.		H. M.
○ 21st September	A.M.	0 20	0 19	A	0 1
	P.M.	0 47	0 42	A	0 5
22nd „	A.M.	0 52	I. 3	B	0 11
	P.M.	I. 9	I. 24	B	0 15
● 4th October	A.M.	XI. 16	X. 41	A	0 35
5th „	A.M.	XI. 50	XI. 33	A	0 17
	P.M.	XI. 58	XI. 59	B	0 1
6th „	P.M.	0 23	0 26	B	0 3
7th „	A.M.	0 35	0 52	B	0 17
	P.M.	0 57	I. 20	B	0 23

It appears from this that the Bore originated by the sudden rise of water in the estuary following the inferior transit of the Full Moon and the superior transit of the New Moon, passes Bhota Pagoda, Haining, precisely at the minute of the superior transit of the Full Moon and the inferior transit of the New Moon; that, speaking generally, it may be said that the Bore passes Haining as the moon crosses the meridian, and that on very calm days (such as 4th October) it is behind time, while in strong on-shore winds it comes in early.

III. The name given by the Chinese to the Bore is simply "Chau"—the tide. Sometimes they speak of it at Haining as "Chau dau," the "Great Tide." I have asked several of them, and they can give no reasonable explanation of the flood coming in this particular manner, but all emphatically declare it to be a bad Fung-shui. It is not surprising that they should make such a phenomenon the object of superstition and the theme of romance, devoted as they are to "fung-shui"—or the occult influence of air and water. At Haining the story believed in by the junk men is this :—Many hundred years ago there was a certain general, who had obtained many victories over the enemies of the Emperor, and who, being constantly successful, and deservedly popular among his countrymen, excited the jealousy of his sovereign, who had for some time observed, with secret wrath, his growing influence. The Emperor, accordingly, caused him to be assassinated and thrown into the Tsien-tang, when his spirit conceived the idea of revenging itself by bringing the tide in from the ocean in such force as to overwhelm the city of Hang-chau, then the magnificent capital of the empire. As my interpreter, who has been for some years in America, put it—" his sowl felt a sort of ugly like, arter the many battles he had got for the Emperor." The spirit so far succeeded as to flood a large portion of the country, when the Emperor, becoming alarmed at the distress and loss of property occasioned, endeavoured to enter into a sort of compact with it by burning paper and offering food upon the sea wall. This, however, did not have the desired effect, as the high tide came in as before, and it was at last determined to erect a Pagoda at the spot where the worst breach in the embankment had been made. Hence the origin of the Bhota Pagoda. A Pagoda induces a good fung-shui. After it was built, the flood tide, though it still continued to come in the shape of a Bore, did not flood the country as before.*

Archdeacon Moule informs me that the natives of Hang-chau hold the Bore in the greatest awe, and are to be found at certain seasons worshipping it as the arbiter of their destiny. During the Taeping rebellion when the city was taken and retaken several times, and thousands of homeless fugitives were crossing the Tsien-tang daily for 2 years, the Bore did not come. The channels are constantly altering and he believes that, owing to some change in the bed of the river or the flats in the estuary, the flood did not reach the city in this shape, or at any rate the roller was comparatively harmless to what it was before, or has been since that disturbed time.

The causes of the Bore appear to be three : 1. The funnel or bell-shape of the Hang-chau gulf which is open to the eastward, between 50 and 60 miles wide at the mouth, and only 10 miles broad at the part where navigation ends, 45 miles to westward, the latter end being of much less general depth of water than across the entrance. 2. The large area of sand flats at the head of the estuary. 3. The outgoing stream from the Tsien-tang-kiang.

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* It is rather remarkable that Marco Polo, who knew Hang-chau well 600 years ago, and describes its wonders, makes no mention of the Bore.—W.J.L.W.

The Chusan archipelago is remarkable for its swift tidal streams which attain a velocity in certain channels of 8 knots at spring tide. Last May it was remarked that the time of high water among the Volcano islands was very different to that at Changtau harbour, although the distance was small; and it was arranged to erect the tide pole at West Volcano island, in any case necessary for the reduction of soundings in the western half of our survey, before the Changtau pole was taken down; and to carry out simultaneous observations of the level of the water about the change of the moon early in September. The result showed that the difference of vulgar establishment between these two stations, only 20 miles apart, was as much as 2 hours; and that at certain times of tides fluctuating between the 3rd and 4th hours of the flood and between the 4th and 6th hours of the ebb at Changtau harbour there was a considerable difference of level in the water, amounting at spring range to over 5 feet.

The comparisons between the levels at various times are shown in in Appendix B. On seeing these, it no longer causes any wonder that the tidal stream between the two stations should get up a velocity of 5 knots and in narrow straits 7 to 8 knots an hour; and it is harmonious with the register that the greatest speed should occur, as the current log, kept on board, shows is the case, when it is about high or low water at Changtau, that is, when the difference of level is neither greatest or least, but half way between, or when the sea is in the middle of its struggle to regain equilibrium and has succeeded in reducing the difference of level between the two stations to one half the maximum of that tide.

On the 8th September the tide pole at Changtau was embarked, and on the 20th it was erected at Rambler island. The distance between Rambler island and West Volcano is 45 miles, and the difference of vulgar establishment only one hour; but, whereas at the latter station the range of tide is 12 feet at springs, at the former it is, owing to the configuration and bed of the Hang-chau gulf—25 feet, and under certain conditions of wind and positions of the moon, as much as 34 feet. Appendix C. shows the comparison between the level of the water at Rambler island and West Volcano island for every half hour from noon 20th September to midnight 22nd.

It became of importance to institute a similar comparison between Rambler island and the Tsien-tang-kiang. Unfortunately this was not practicable. Tide poles were taken away for the purpose, but the difficulty of sheltering the boats, which I have elsewhere explained demanded the premature return of my party. Times of high and low water have, however, been obtained; also the range of spring tide; and a knowledge has been gained of the times of mean sea level and no tide. These are entered in Appendix C.

In computing differences of level between two stations, the mean sea level has been calculated for identical epochs by the method indicated in your General Instructions, combining three groups of lunar and solar days, and eliminating the lunar and solar semi-diurnal and diurnal inequalities.

So far as Rambler island is concerned, this method does not give a result consistent with the actual mean between highest and lowest tides, but a slightly higher mean level. The purely undulatory character of the attraction of the sun and moon has begun to give place to a transmission of particles of water. On inspection of the tables you will notice that about an hour before it is high water at Changtau, when the sea is between one and two feet above mean level at West Volcano island, the water goes up at Rambler island from 9 feet below mean level to 2 feet above in one hour, bringing the difference of level between the two stations from 10 feet West Volcano highest to 2 feet West Volcano, also highest: the rise at Rambler island being five times as much as that at West Volcano island, or just in that proportion which the breadth of the estuary at the former place bears to the width of the mouth where West Volcano island is situated. Here is a tremendous force. Water banking up into the small end of a funnel, running down hill, and having in front a vast field of sand, the greater portion of which is dry when this force is set in motion, and indeed for some minutes afterwards. Presently the water begins to set over the flats slowly, but no doubt with more velocity and tumult through the very narrow channels kept open by the Tsien-tang-kiang. When 2 feet of the sand is covered, the flood stream runs with great impetuosity. Friction caused by the ground, and by the swift outgoing streams of the river, impedes its foot: an overfall is formed, first no doubt, and always higher, in the channels. By and bye, a greater volume overlays the first of the flood, and having less to contend against, runs forward and falls in front also to be checked by the river stream; and so on, until in half-an-hour the Bore is formed, and as more water comes up behind, it gathers in height and has sufficient force to proceed on its course towards the river.

It cannot take long to form, for the interval between the beginning of the quick rise at Rambler island and the time of the Bore passing Haining is 2½ hours, and it has to travel 29 miles.

The difference of level between the entrance of the river and Rambler island at the time the two branches of the Bore effect a junction and it commences to contract in width, is 19 feet; and it is probably travelling faster at that time than at any previous period.

The accompanying diagram will help to show the birth of the Bore and the power propelling it. The violence of the rush which follows the cascade, and which drove our boats 3 miles from their anchorage on the night of the 20th September, is accounted for by the difference of level between Rambler island and Haining, which is 4 to 6 feet for an hour after the Bore has passed, and decreases very slowly up to the time of high water at Haining. The water at Rambler island is then falling fast, and has come down to the level of that of Haining. As the estuary at Rambler island is four times as broad as the river, and the force of attraction does not in this case enter into the question, directly the water at this station falls below that of Haining, the stream must inevitably set out of the river; and we found it did so directly after high water.

The river falls very rapidly, following close upon the water at Rambler island which is in the full swing of its downward course when the river has only just begun. It is at mean level 2 hours after high water: at the 5th hour ebb it is nearly low water; the last foot dribbles away very slowly; and for 2 hours before the arrival of the Bore the water falls only 3 or 4 inches. The stream, however, of the river continues to make out fast along the channel and is found opposing the Bore, which it helps to create.

At Rambler island the ebb stream was found to be strongest between the 2nd and 3rd hours fall and to be practically *nil* after the 4th hour. The links of the cable were bent surging about after the 2nd hour. The tables show that the difference of level between Rambler island and West Volcano island is then about half the maximum, West Volcano lowest; and that at the 4th hour, the two stations are on the same level. The stream from the river still comes out, but is expanding to the greater breadth of the estuary.

I will now combine Appendices B and C, noting that it is high water full and change at Changtau harbour Xh. 14m., West Volcano island 0h. 19m., Rambler island 1h. 27m. Haining III. hrs. 0m., and Hang-chau III. hrs. 0m. (approx.) The Bore passes Haining 0 hrs. 0., and the city of Hang-chau at 1h. 30m. (approx.)

To trace the progress and inclination of the tidal waves which follow Full Moon of 20th September from the ocean to the Hangchau estuary, it will be sufficiently accurate to adopt the differences of level observed between West Volcano island and Changtau harbour on the 6th and 7th September, as the time and height of high water at West Volcano island, were the same on both full and change of the moon.

20th Sept., 1888. p.m.	Diff.: Level between Rambler I. and and West Volcano I.		West Volcano, highest or lowest.	Diff. Level between Chang-tau Har. and West Volcano I.		West Volcano, highest or lowest.	Diff. Level between Rambler I. and Chang-tau Har.		Chang-tau, highest or lowest.
h. m.	ft.	m.		ft.	in.		ft.	in.	
Noon.	3	10	L.	1	10	H.	5	8	L.
O 30	5	0	L.	2	5	H.	7	5	L.
I. 0	6	5	L.	3	2	H.	9	7	L.
I. 30	7	4	L.	3	6	H.	10	10	L.
II. 0	8	0	L.	3	7	H.	11	7	L.
II. 30	8	7	L.	3	8	H.	12	3	L.
III. 0	8	2	L.	3	10	H.	12	0	L.
III. 30	4	8	L.	3	10	H.	8	6	L.
IV. 0	5	1	L.	3	4	H.	8	5	L.
IV. 30	4	0	L.	2	8	H.	6	8	L.
V. 0	2	0	L.	1	6	H.	3	6	L.
V. 30	0	2	H.	0	3	L.	0	5	H.
VI. 0	1	9	H.	1	8	L.	3	5	H.
VI. 30	3	7	H.	3	1	L.	6	8	H.
VII. 0	5	6	H.	4	2	L.	9	8	H.
VII. 30	7	2	H.	4	8	L.	11	10	H.
VIII. 0	8	10	H.	4	11	L.	13	9	H.
VIII. 30	10	3	H.	4	8	L.	14	11	H.
IX. 0	11	1	H.	4	1	L.	15	2	H.
IX. 30	10	4	H.	3	4	L.	13	8	H.
X. 0	6	10	H.	2	9	L.	9	7	H.
X. 30	2	3	H.	1	11	L.	4	2	H.
XI. 0	1	5	L.	0	10	L.	0	7	H.
XI. 30	3	4	L.	0	3	H.	3	7	L.
Mdnght.	4	0	L.	1	5	H.	5	5	L.
21st SEPTEMBER.—A.M.									
O. 30	4	9	L.	2	3	H.	7	0	L.
I. 0	6	1	L.	3	1	H.	9	2	L.
I. 30	7	1	L.	3	4	H.	10	5	L.
II. 0	7	10	L.	3	4	H.	11	2	L.
II. 30	8	6	L.	3	7	H.	12	1	L.
III. 0	8	6	L.	3	11	H.	12	5	L.
III. 30	6	9	L.	4	1	H.	10	10	L.
IV. 0	5	9	L.	3	11	H.	9	8	L.
IV. 30	4	4	L.	3	9	H.	8	1	L.

21st Sept., 1888. Hour.	Diff. Level between Rambler I. and West Voloano I.		West Volcano, highest or lowest.	Diff. Level between Chang-tau Har. and West Volcano I.		West Volcano, highest or lowest.	Diff. Level between Rambler I. and Chang-tau Har.		Changtau, highest or lowest.
H. M.	Ft.	in.		Ft.	in.		Ft.	in.	
V. 0	2	11	L.	2	11	H.	5	10	L.
V. 30	1	2	L.	1	7	H.	2	9	L.
VI. 0	0	6	H.	0	0		0	6	L.
VI. 30	2	5	H.	1	8	L.	4	1	H.
VII. 0	3	9	H.	3	4	L.	7	1	H.
VII. 30	5	1	H.	4	6	L.	9	7	H.
VIII. 0	6	10	H.	5	0	L.	11	10	H.
VIII. 30	8	11	H.	5	0	L.	13	11	H.
IX. 0	10	4	H.	4	8	L.	15	0	H.
IX. 30	11	1	H.	4	6	L.	15	7	H.
X. 0	10	2	H.	3	8	L.	13	10	H.
X. 30	5	1	H.	2	10	L.	7	11	H.
XI. 0	0	3	H.	1	7	L.	1	10	H.
XI. 30	1	5	L.	0	6	H.	0	11	L.
Noon.	3		L.	0	5	H.	4	1	L.
O. 30	4	6	L.	1	7	H.	6	1	L.
I. 0	5	4	L.	2	5	H.	7	9	L.
I. 30	6	2	L.	3	2	H.	9	4	L.
II. 0	7	4	L.	3	4	H.	10	8	L.
II. 30	8	2	L.	3	7	H.	11	9	L.
III. 0	8	7	L.	3	10	H.	12	5	L.

This table shows that two hours before high water at Changtau, when the apex of the tidal wave is over the deep water of the ocean, there is a difference of level of 15 feet between the water at Changtau harbour and Rambler island. There is no indication of remarkable pressure at West Volcano island, which is at the mouth of the Hang-chau gulf; but an hour later, when the apex of the wave is nearing the Chusan archipelago, there is great pressure on the water in the Hang-chau estuary and the difference of level of the water between Changtau and Rambler island reduces 13 feet in one hour and a half. Judging by the analagous case of Changtau and West Volcano, the strongest flood stream would be when this difference is reduced by one half, that is to say, when the water is in its full swing of effort to regain equilibrium. It is then high water at Changtau, and the Bore forms west of Rambler island.

The Bore cannot be accurately described as a "wave." It is in no sense an undulation; nor is there any depression after it has passed. The same particles of water which rise with such a significant jump in the neighbourhood of Rambler island, are precipitated over the vast bar of sand into the Tsien-tang. It is in this the danger lies. In its effort to find equilibrium the flood is travelling at a rate of 12 to 13 miles an hour, and overcomes everything in its progress. A wave, or two waves, of 6 to 10 feet in height may be safely encountered by a craft having good anchors and cables. Not so the Bore. Supposing one of H.M. gunboats to be anchored off Haining with stern anchor to prevent swinging to the out-going stream, and an anchor and whole cable out on each bow, I think it is doubtful if she would not founder in a good spring tide Bore such as is described by the natives as happening occasionally in the winter months.

So far from there being any depression behind the cascade, our observations show that it is always succeeded by a rise of 3 or 4 feet of water. If the estuary terminated at Rambler island, or the place marked as Canpu, we should probably see a rise of 50 or 60 feet as in the Bay of Fundy ; but the outlet being there, the pent up waters discharge themselves through it, and as soon as the level at their source falls below them, they fall also. If asked for a brief definition of the Bore, I would say—Two thirds of the flood range of the day arrives in the river, at any given spot, in a quarter of an hour ; and in such a form as to show the observer a well defined body of water advancing at a high speed many feet above the level of the river where he is situated.

The front or crest of this flood is in the shape of a bubbling cascade of foam, about as high as the mean river level, pounding itself and the sea in front of it in precisely the same manner as the first onset of the ordinary flood tide on a stretch of sand.

Anyone who has witnessed the coming in of the flood on the flats at Weston-super-mare, for instance, has seen a Bore on a minature scale. On a very calm day, standing on the sea wall, I found it difficult—if the Bore was small—to divest my mind of the idea, that I was looking at the same sort of thing. The placid river became sand in imagination and the regular line of foam nothing but a bigger and noisier ripple. In boisterous weather the scene is different. There is the same bubbling cascade, but the line is not so regular. Squalls in the estuary appear to be whipping up the flood ; the waves in the river destroy the illusion of sand, the fierce rebound from the sea wall, the hurtling ripple on the back of the Bore with its waves tossed hither and thither and throwing up clouds of spray ; the height and noise remind the spectator that he is looking upon one of the violent forces of nature.

From the shallow side of the river, that is the south bank at Haining and the north bank at the city, the pounding cascade does not strike the attention so much as the breakers along the side of the Bore, which lags on account of the gradual slope of the sand.

It is improbable that the height of the cascade ever exceeds 15 or 16 feet as the first rush of the flood depends upon the quick rise in the neighbourhood of Rambler island; and there is no reason to suppose that, even in a typhoon, this ever exceeds by 6 feet what was recorded by the Rambler's party.

The Bishop of Mid-China estimated 15 feet as the height of one Bore which he saw from the sea wall 5 miles east of Hang-chau. Doctor Main measured down the wall at the same spot, on one occasion, before the Bore arrived, and after it had passed; and made the difference 12 feet.* The effect of a rebound from the sea wall such as happens daily east of Haining, is to raise water from 5 to 15 feet above the Bore, making a total of 20 to 30 feet under very exceptional circumstances; but only for a few minutes.

The locality where the flood ceases to form mere ripplings and to create a Bore, no doubt varies very much with the wind at the mouth of the gulf, the age of the moon, and the strength of the outgoing stream of the river. On rare occasions it is something more than a mere overfall off Chapu 40 miles from Haining; but as a rule, an ordinary spring-tide Bore would form a few miles east of Chi-san, 12 to 16 miles from Haining. I have heard the muttering I. h. 20m. before the Bore arrived, and at that time it could not be less than 12 miles distant. It is improbable that I heard it immediately it was formed, because I had very little experience of the sound, and there was a certain amount of noise around, caused by the lapping of the waves and rippling of the river stream.

The position where the Bore vanishes, and nothing remains but a swift rush, is also variable.

The Bishop experienced the Bore on the 29th of May this year, at a place which is about 40 miles from Haining. As a rule, I believe, it expires just above the city, at springs. Its usual life, then, is 3 to 4 hours, during which time it travels 34 to 40 miles; but under certain rare combinations of wind, tide, and strong outgoing stream, it may have a life of 7 or 8 hours, and travel as much as 80 to 90 miles.

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* The 30 feet estimate of Dr. MacGowan, in his paper read before the China Branch of the Royal Asiatic Society, is a very erroneous one; and this at the *city* where the range is 6 feet! No combination of wind and tide could produce a Bore off the city over 8 feet high.

The sound in the distance is peculiar, and no exactly like any other. It most nearly resembles the leaden noise of breakers on a distant coral reef, being a continuous muttering, broken only by an occasional dull thud, indicating some new addition to the flood, or some exceptionally heavy breaker. As it approaches, the sound increases very gradually until it passes with a roar, but little inferior to the rapids below Niagara.

To sum up.—From observations made at full and change of the moon, and information received from reliable witnesses, I feel justified in submitting to you the following general conclusions.

At full and change of the moon the Bore of the Tsien-tang-kiang originates between X. h. and X. h. 30 m. in the neighbourhood of the meridian of Chi-san, a conspicuous hill 12 miles E. by S. ½ S. from Haining. On a still night, it can be heard from Haining within half an-hour after it is formed. It is divided into two branches, one of which keeps along the shore, touching the sea wall with its north extreme, and the sands with its south extreme; this is the main Bore, and the highest.

The other appears in view at Haining from a south-easterly direction, touching sand on both sides. When 4 miles from Haining, the branches join, the right extreme of the first with the left extreme of the second, making a continuous white line 2 miles in length. Shortly afterwards, the Bore commences to contract in width, increase in speed, and rise in height, conforming to the mouth of the river. When 2 miles from Haining, the flood stream (probably that from the south-east which runs through the other) charges into the sea wall. There is no particular effect at the wall itself; but a violent rebound, causing a tumultuous rising of the waters in waves several hundred yards behind, but twice as high again as the front of the Bore. These waves are in existence for many minutes, travelling in a southerly or south-westerly direction; and, after a time, subside on to the back of the Bore. Precisely as the moon crosses the meridian, the Bore passes Haining, where it is nearly a straight line across the river, 9 cables wide, 8 to 11 feet high, and travelling between 12 and 13 knots an hour; its front being a uniform sloping cascade of bubbling foam, falling forward and pounding on itself and on the river before it at an angle of between 40° and 70°. The highest and steepest part is over the deep channel of the river.

The north edge of the Bore swells up to the sea wall as it goes along, but the south side, meeting as it does a very gradual incline of sand which only rises 19 feet in 1·4 miles, trails away in a tapering wall of very deliberate breakers, which end half a mile astern (where the Bore passed 3 or 4 minutes previously). The river fills up to the level of the Bore soon after it passes, but not evenly. The height, speed and regular appearance of the front are maintained for 15 miles above Haining; after which the Bore decreases in height, and passes the city of Hang-chau at I. 45, soon to break up and disappear.

A quarter of an hour after the Bore has passed Haining the water has risen to 13 feet, and at II. hours to 18 feet. It is high water 19 feet at III. hours, and the stream at once commences to run out swiftly. At V. hours it is at the mean level: at VIII. hours it is nearly low water. The outgoing stream, however, continues to run to the eastward with great velocity until the arrival of the next Bore. The water is at its lowest for the 2 hours preceding the Bore.

It is high water at the city of Hang-chau about the same time as at Haining, but the rise and fall does not exceed 6 or 7 feet.

At Haining, therefore, the flood lasts for 3 hours, the ebb, if such it may be called, for 9 hours. At the city the flood continues for 1¼ hours, and is nearly all in the Bore.

There is no place in the river where boats can be secured in safety 2½ hours after high water. All traffic between Haining and Hang-chau begins soon after the Bore has passed, and ends 2 hours after high water, a period of from 3 to 4 hours.

On the right, or south, bank of the Tsien-tang, the stream—at any rate for 5 or 6 miles inside the mouth of the river—commences to run out strong an hour before high water at Haining.

Opposite the city the Bore, if it occurs at all, is not regarded in any way dangerous for 15 or 20 days in the month.

At Haining the natives state positively that it comes with every flood tide; but that in calm weather and neaps it is only 2 or 3 feet high.

It is probably always dangerous on account of its speed. At springs. I have shown it is most formidable. Navigation for ships is out of the question.

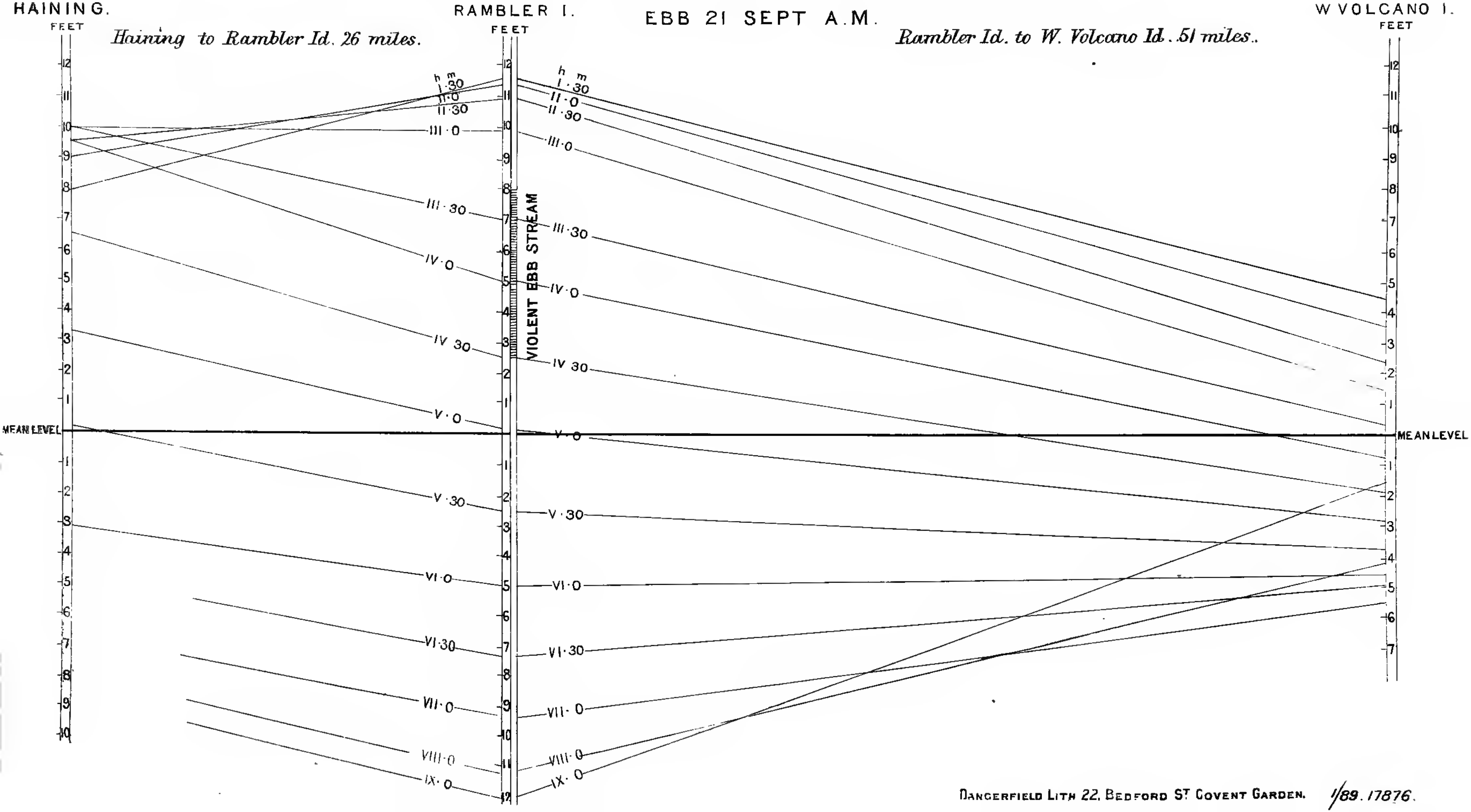
The regularity of its appearance and shape, the distance at which it is heard at night and seen by day; its charge against the sea wall; its speed, height gleaming front, and thundering roar as it tears past the observer, render it a most impressive phenomenon.

I have the honour to be
Sir,
Your most obedient Servant,
W. USBORNE MOORE,
Commander.

The Hydrographer of the Admiralty.

DIAGRAM SHOWING SPEEDY FALL ON THE EBB.

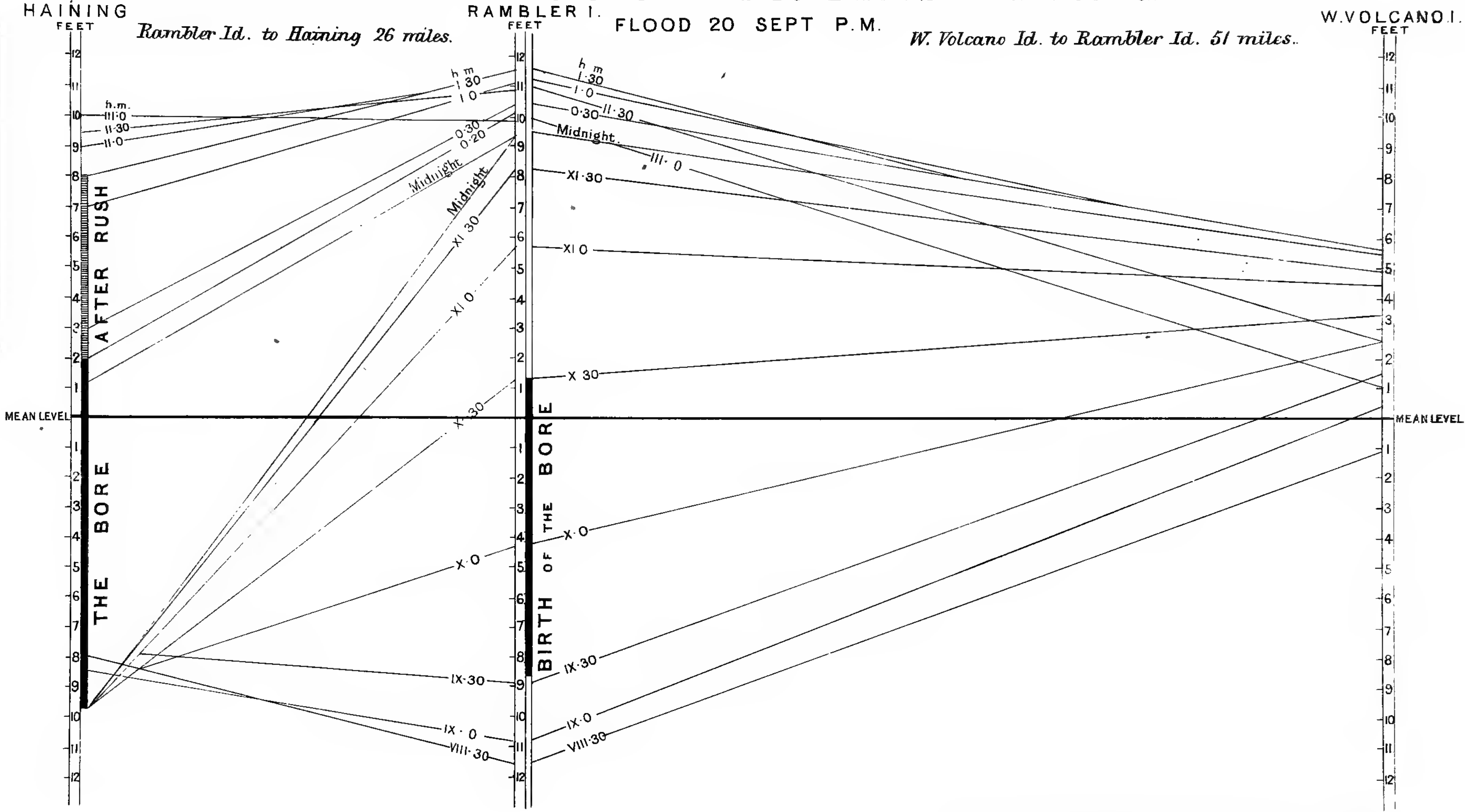
EBB 21 SEPT A.M.



DANCERFIELD LITH 22, BEDFORD ST COVENT GARDEN. 1/89. 17876.

DIAGRAM SHOWING THE PROJECTION OF THE BORE AND THE AFTER RUSH ON THE FLOOD

FLOOD 20 SEPT P.M.



DANCERFIELD LITH 22, BEDFORD ST. COVENT GARDEN. 189 17876

APPENDIX A.

Simultaneous observations of the differences of water level at Changtau harbour and West Volcano island 4th September to 8th September 1888.

4th September 1888. Hour.	Above or below Mean Sea Level.				Difference of level.		Remarks.
	Changtau.		W.Volcano				
P.M.	Ft.	in.	Ft.	in.	Ft.	in.	
IV. 0	−4	4	−4	7	0	3	
IV. 30	−3	7	−5	1	1	6	
V. 0	−2	8	−5	0	2	4	
V. 30	−1	6	−4	7	3	1	
VI. 0	−0	2	−3	8	3	6	
VI. 30	+1	3	−2	6	3	9	
VII. 0	+2	7	−1	1	3	8	
VII. 30	+3	8	−0	1	3	9	
VIII. 0	+4	5	+1	2	3	3	
VIII. 30	+5	1	+2	5	2	8	
IX. 0	+5	4	+3	7	1	9	IX. 5, High Water Changtau harbour.
IX. 30	+5	3	+4	8	0	7	
X. 0	+5	0	+5	4	0	4	
X. 30	+4	5	+5	6	1	1	
XI. 0	+3	9	+5	2	1	5	
XI. 30	+3	2	+4	10	1	8	
Midnight.	+2	4	+4	4	2	2	

5TH SEPTEMBER 1888.

A.M.	Ft.	in.	Ft.	in.	Ft.	in.	
0. 30	+1	4	+3	9	2	5	
I. 0	+0	3	+3	2	2	11	
I. 30	−0	10	+2	6	3	4	
II. 0	−1	10	+1	4	3	2	
II. 30	−2	9	+0	4	3	1	
III. 0	−3	8	−0	9	2	11	
III. 30	−4	0	−1	9	2	3	h. m.
IV. 0	−4	1	−2	7	1	6	III. 55, Low Water Changtau.
IV. 30	−3	11	−3	5	0	6	
V. 0	−3	5	−4	4	0	11	
V. 30	−2	7	−4	9	2	2	
VI. 0	−1	6	−4	10	3	4	
VI. 30	−0	3	−4	3	4	0	
VII. 0	+0	10	−3	2	4	0	
VII. 30	+1	11	−2	0	3	11	
VIII. 0	+2	9	−1	0	3	9	
VIII. 30	+3	4	+0	1	3	3	

APPENDIX A.—*cont.*

5th September 1888.	Above or below Mean Sea Level.		Difference of level.	Remarks.
Hour.	Changtau.	W.Volcano		
A.M.	Ft. in.	Ft. in.	Ft. in.	h. m.
IX. 0	+3 6	+1 0	2 6	IX. 5, High Water Changtau.
IX. 30	+3 5	+1 10	1 7	
X. 0	+3 2	+2 8	0 6	
X. 30	+2 10	+3 1	0 3	
XI. 0	+2 6	+3 9	1 3	
XI. 30	+1 11	+3 9	1 10	
Noon.	+1 0	+3 5	2 5	
P.M.				
O. 30	0 0	+2 11	2 11	
I. 0	−1 1	+2 2	3 3	
I. 30	−2 4	+1 0	3 4	
II. 0	−3 5	+0 2	3 7	
II. 30	−4 4	−0 10	3 6	
III. 0	−4 11	−1 8	3 3	
III. 30	−5 5	−2 7	2 10	
IV. 0	−5 6	−3 6	2 0	III. 50 L.W. Changtau.
IV. 30	−5 2	−4 3	0 11	
V. 0	−4 5	−5 0	0 7	
V. 30	−3 6	−5 6	2 0	
VI. 0	−2 6	−5 6	3 0	
VI. 30	−1 2	−4 9	3 7	
VII. 0	+0 5	−3 5	3 10	
VII. 30	+2 0	−2 4	4 4	
VIII. 0	+4 0	−1 5	5 5	
VIII. 30	+4 9	+0 4	4 5	
IX. 0	+5 2	+2 2	3 0	
IX. 30	+5 5	+3 7	1 10	IX. 45 H.W Changtau.
X. 0	+5 5	+4 7	0 10	
X. 30	+5 2	+5 5	0 3	
XI. 0	+4 9	+5 9	1 0	
XI. 30	+4 3	+5 10	1 7	
Midnight.	+3 7	+5 9	2 2	
6TH SEPTEMBER 1888.				
A.M.				
O. 30	+2 5	+5 5	3 0	
I. 0	+1 3	+4 6	3 3	
I. 30	+0 2	+3 5	3 3	
II. 0	−1 0	+2 2	3 2	
II. 30	−2 2	+0 11	3 1	
III. 0	−3 2	−0 1	3 1	
III. 30	−4 0	−1 2	2 10	
IV. 0	−4 6	−1 10	2 8	
IV. 30	−4 8	−2 7	2 1	IV. 35 L.W. Changtau.

APPENDIX A.—*cont.*

6th September 1888.	Above or below Mean Sea Level.		Difference of level.	Remarks.
Hour.	Changtau.	W. Volcano		
A.M.	Ft. in.	Ft. in.	Ft. in.	
V. 0	−4 7	−3 8	0 11	
V. 30	−4 4	−4 7	0 3	
VI. 0	−3 5	−5 5	2 0	
VI. 30	−2 1	−5 7	3 6	
VII. 0	−0 11	−5 1	4 2	
VII. 30	+0 4	−3 11	4 3	
VIII. 0	+1 6	−2 7	4 1	
VIII. 30	+2 10	−1 5	4 3	
IX. 0	+3 5	−0 3	3 8	
IX. 30	+3 8	+0 9	2 11	IX. 45 H.W. Changtau.
X. 0	+3 8	+1 9	1 11	
X. 30	+3 6	+2 7	0 11	
XI. 0	+3 2	+3 1	0 1	
XI. 30	+2 7	+3 7	1 0	
Noon.	+1 11	+3 9	1 10	
P.M.				
O. 30	+1 0	+3 5	2 5	
I. 0	−0 1	+3 1	3 2	
I. 30	−1 3	+2 3	3 6	
II. 0	−2 5	+1 2	3 7	
II. 30	−3 8	0 0	3 8	
III. 0	−4 10	−1 0	3 10	
III. 30	−5 10	−2 0	3 10	
IV. 0	−6 4	−3 0	3 4	
IV. 30	−6 7	−3 11	2 8	IV. h. 40 m. L. W. Changtau.
V. 0	−6 5	−4 11	1 6	
V. 30	−5 9	−6 0	0 3	
VI. 0	−4 10	−6 6	1 8	
VI. 30	−3 7	−6 8	3 1	
VII. 0	−2 1	−6 3	4 2	
VII. 30	−0 1	−4 9	4 8	
VIII. 0	+1 11	−3 0	4 11	
VIII. 30	+3 5	−1 3	4 8	
IX. 0	+4 5	+0 4	4 1	
IX. 30	+5 1	+1 9	3 4	
X. 0	+5 7	+2 10	2 9	X. h. 25 m. H. W. Changtau.
X. 30	+5 8	+3 9	1 11	
XI. 0	+5 5	+4 7	0 10	
XI. 30	+5 0	+5 3	0 3	
Midnight	+4 5	+5 10	1 5	

7TH SEPTEMBER 1888.

Hour.	Changtau.	W. Volcano	Difference of level.	Remarks.
A.M.				
O. 30	+3 7	+5 10	2 3	
I. 0	+2 5	+5 6	3 1	
I. 30	+1 4	+4 8	3 4	

APPENDIX A.—*cont.*

7th September 1888. Hour.	Above or below Mean Sea Level.		Difference of level.	Remarks.
	Changtau.	W.Volcano		
A.M.	Ft. in.	Ft. in.	Ft. in.	
II. 0	+0 3	+3 7	3 4	
II. 30	−1 0	+2 7	3 7	
III. 0	−2 4	+1 7	3 11	
III. 30	−3 6	+0 7	4 1	
IV. 0	−4 4	−0 5	3 11	
IV. 30	−5 2	−1 5	3 9	
V. 0	−5 6	−2 7	2 11	Vh. 0m. L.W. at Changtau.
V. 30	−5 4	−3 9	1 7	
VI. 0	−5 0	−5 0	0 0	
VI. 30	−4 1	−5 9	1 8	
VII. 0	−2 11	−6 3	3 4	
VII. 30	−1 4	−6 0	4 6	
VIII. 0	+0 6	−4 6	5 0	
VIII. 30	+2 0	−3 0	5 0	
IX. 0	+3 1	−1 7	4 8	
IX. 30	+4 0	−0 6	4 6	
X. 0	+4 3	+0 7	3 8	
X. 30	+4 4	+1 6	2 10	Xh. 30m. H.W. at Changtau.
XI. 0	+4 3	+2 8	1 7	
XI. 30	+3 11	+3 5	0 6	
Noon	+3 4	+3 9	0 5	
P.M.				
0 30	+2 6	+4 1	1 7	
I. 0	+1 7	+4 0	2 5	
I. 30	+0 5	+3 7	3 2	
II. 0	−0 7	+2 9	3 4	
II. 30	−1 10	+1 9	3 7	
III. 0	−3 1	+0 9	3 10	
III. 30	−4 2	−0 3	3 11	
IV. 0	−5 4	−1 3	4 1	
IV. 30	−6 0	−2 6	3 6	
V. 0	−6 3	−3 5	2 10	V. h. 25 m. L.W. Changtau.
V. 30	−6 5	−4 3	2 2	
VI. 0	−5 8	−5 0	0 8	
VI. 30	−4 9	−5 10	1 1	
VII. 0	−3 5	−6 0	2 7	
VII. 30	−1 7	−5 2	3 7	
VIII. 0	+0 6	−4 2	4 8	
VIII. 30	+2 2	−3 0	5 2	
IX. 0	+3 7	−1 6	5 1	
IX. 30	+5 0	0 0	5 0	
X. 0	+5 7	+1 4	4 3	
X. 30	+5 11	+2 7	3 4	
XI. 0	+6 1	+3 8	2 5	XI.h. 5m. H.W. at Changtau.
XI. 30	+6 0	+4 11	1 1	
Midnight	+5 8	+5 11	0 3	

APPENDIX A.—*cont.*

8th September 1888. Hour.	Above or below Mean Sea Level.		Difference of level.	Remarks.
	Changtau.	W. Volcano		
A.M.	Ft. in.	Ft. in.	Ft. in.	
O. 30	+4 9	+6 4	1 7	
I. 0	+4 2	+6 5	2 3	
I. 30	+3 3	+6 3	3 0	
II. 0	+2 1	+5 9	3 8	
II. 30	+1 0	+4 9	3 9	
III. 0	−0 1	+3 7	3 8	
III. 30	−1 8	+2 5	4 1	
IV. 0	−3 1	+1 3	4 4	
IV. 30	−4 0	+0 3	4 3	
V. 0	−4 6	−0 6	4 0	
V. 30	−4 10	−1 8	3 2	V. h. 50 m. L.W. Changtau.
VI. 0	−4 11	−2 9	2 2	
VI. 30	−4 6	−3 8	0 10	
VII. 0	−3 7	−4 10	1 3	
VII. 30	−2 4	−5 5	3 1	
VIII. 0	−1 1	−5 3	4 2	
VIII. 30	+0 3	−4 4	4 7	
IX. 0	+2 7	−2 4	5 1	
IX. 30	+3 8	−1 0	4 8	
X. 0	+4 9	+0 2	4 7	
X. 30	+5 2	+1 4	3 10	X. h. 50 m. H.W. at Changtau.
XI. 0	+5 2	+2 3	2 11	
XI. 30	+5 0	+3 4	1 8	
Noon	+4 7	+4 5	0 2	

APPENDIX B.

Simultaneous observations of the distance of the water from mean level at Haining, Rambler island, and West Volcano island. Full Moon, September 1888.

20th September 1888. Hour.	Above or below Mean Level.			Diff. Level between Rambler Island and W. Volcano Island.	Remarks.
	Haining.	Rambler Island.	West Volcano.		
	Ft. in.	Ft. in.	Ft. in.	Ft. in.	
Noon.	...	+ 8 2	+4 4	3 10	
0. 30	...	+ 9 3	+4 3	5 0	
I. 0	...	+10 1	+3 8	6 5	
I. 30	+9 0	+10 4	+3 0	7 4	
II. 0	+9 6	+10 0	+2 0	8 0	

APPENDIX B.—*Cont.*

20th September 1888. Hour.	Above or below Mean Level.			Diff. Level between Rambler Island and W. Volcano Island.	Remarks.
	Haining.	Rambler island.	W. Volcano		
P.M.	Ft. in.	Ft. in.	Ft. in.	Ft. in.	
II. 30	+9 6	+ 9 6	+0 11	8 7	
III. 0	+9 0	+ 8 1	−0 1	8 2	
III. 30	...	+ 5 9	−1 1	4 8	
IV. 0	...	+ 3 3	−1 10	5 1	
IV. 30	...	+ 1 2	−2 10	4 0	
V. 0	0 0	− 1 5	−3 6	2 1	
V. 30	...	− 4 5	−4 3	0 2	
VI. 0	...	− 6 5	−4 8	1 9	
VI. 30	...	− 8 6	−4 11	3 7	
VII. 0	...	−10 2	−4 8	5 6	
VII. 30	...	−10 11	−3 9	7 2	
VIII. 0	...	−11 3	−2 5	8 10	
VIII. 30	...	−11 4	−1 1	10 3	
IX. 0	...	−10 9	+0 4	11 1	
IX. 30	−8 0	− 8 10	+1 6	10 4	Birth of the Bore.
X. 0	−9 0	− 4 3	+2 7	6 10	
X. 30	−9 0	+ 1 3	+3 6	2 3	
XI. 0	−9 6	+ 5 9	+4 4	1 5	
XI. 30	−9 6	+ 8 3	+4 11	3 4	Pressure on Rambler island removed.
Midnight.	−9 9	+ 9 6	+5 6	4 0	Bore passed Haining XII. 20.

21ST SEPTEMBER 1888.

A.M.					
O. 30	+ 3 0	+10 4	+5 7	4 9	
I. 0	+ 7 0	+11 3	+5 2	6 1	
I. 30	+ 8 0	+11 7	+4 6	7 1	
II. 0	+ 9 0	+11 5	+3 7	7 10	
II. 30	+ 9 6	+10 11	+2 5	8 6	
III. 0	+10 0	+ 9 10	+1 4	8 6	
III. 30	+10 0	+ 7 0	+0 3	6 9	
IV. 0	+ 9 6	+ 5 0	−0 9	5 9	
IV. 30	...	+ 2 6	−1 10	4 4	
V. 0	...	+ 0 1	−2 10	2 11	
V. 30	0 0	− 2 7	−3 9	1 2	
VI. 0	...	− 5 0	−4 6	0 6	
VI. 30	...	− 7 5	−5 0	2 5	
VII. 0	...	− 9 3	−5 6	3 9	
VII. 30	...	−10 5	−5 4	5 1	
VIII. 0	...	−11 3	−4 5	6 10	
VIII. 30	...	−11 9	−2 10	8 11	

APPENDIX B.—*cont.*

21st September 1888. Hour.	Above or below Mean Level.			Diff. Level between water at Rambler I. and W. Volcano.	Remarks.
	Haining.	Rambler Island.	W.Volcano		
A.M.	Ft. in.	Ft. in.	Ft. in.	Ft. in.	
IX. 0	...	−12 0	−1 8	10 4	
IX. 30	...	−11 8	−0 7	11 1	
X. 0	− 9 0	− 9 4	+0 10	10 2	Birth of the Bore.
X. 30	− 9 0	− 3 6	+1 7	5 1	
XI. 0	− 9 0	+ 2 3	+2 6	0 3	
XI. 30	− 9 0	+ 4 7	+3 2	1 5	Pressure removed from Rambler island.
Noon.	− 9 6	+ 7 3	+3 7	3 8	
P.M. 0. 30	− 9 6	+ 8 3	+3 9	4 6	0. 36 Bore passed Haining.
I. 0	+ 4 0	+ 8 11	+3 7	5 4	
I. 30	...	+ 9 6	+3 4	6 2	
II. 0	...	+ 9 10	+2 6	7 4	
II. 30	+ 9 0	+ 9 7	+1 5	8 2	
III. 0	+ 9 0	+ 8 11	+0 4	8 7	
III. 30	+ 9 0	+ 7 5	−0 10	8 3	
IV. 0	+ 9 0	+ 5 3	−1 8	6 11	
IV. 30	...	+ 2 9	−2 8	5 5	
V. 0	...	+ 0 4	−3 8	4 0	
V. 30	0 0	− 2 3	−4 4	2 1	
VI. 0	...	− 4 8	−4 11	0 3	
VI. 30	...	− 7 1	−5 10	1 3	
VII. 0	...	− 9 2	−6 1	3 1	
VII. 30	...	−10 8	−6 0	4 8	
VIII. 0	...	−11 6	−5 3	6 3	
VIII. 30	...	−12 0	−3 10	8 2	
IX. 0	...	−12 5	−2 4	10 1	
IX. 30	...	−12 4	−0 11	11 5	
X. 0	...	−10 7	+0 4	10 11	Birth of the Bore.
X. 30	...	− 4 6	+1 7	6 1	
XI. 0	− 9 0	+ 1 3	+2 8	1 5	
XI. 30	− 9 0	+ 4 9	+3 4	1 5	Pressure at Rambler I. removed.
Midnight.	− 9 0	+ 6 11	+4 0	2 11	

22ND SEPTEMBER 1888.

A.M. 0. 30	−9 0	+ 8 0	+4 4	3 8	0. 52 Bore passed Haining.
I. 0	+3 0	+ 8 11	+4 6	4 5	
I. 30	...	+10 2	+4 4	5 10	
II. 0	...	+10 6	+3 10	6 8	
II. 30	...	+10 7	+2 8	7 11	

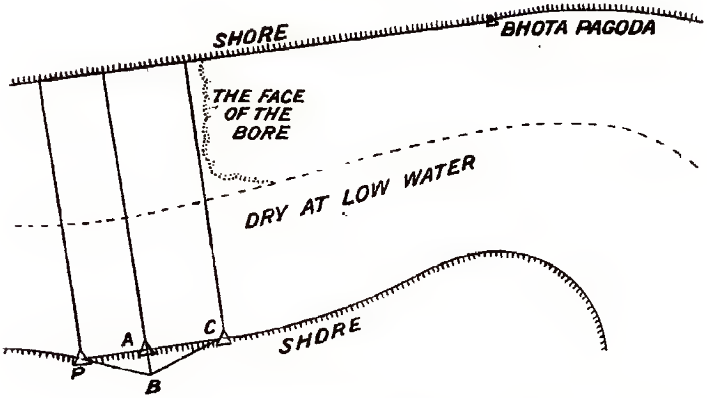
APPENDIX B.—*cont.*

22nd September 1888. Hour.	Above or below Mean Level.						Diff. Level between Rambler Island and W. Volcano Island.		Remarks.
	Haining.		Rambler Island.		W. Volcano				
A.M.	Ft.	in.	Ft.	in.	Ft.	in.	Ft.	in.	
III. 0	+ 9	0	+10	3	+1	7	8	8	
III. 30	+ 9	0	+ 9	0	+0	7	8	3	
IV. 0	+ 9	6	+ 7	3	−0	4	7	7	
IV. 30	+ 9	0	+ 4	6	−1	6	6	0	
V. 0	...		+ 1	11	−2	7	4	6	
V. 30	...		− 0	7	−3	2	2	7	
VI. 0	0	0	− 2	9	−3	11	1	2	
VI. 30	...		− 6	3	−4	8	1	7	
VII. 0	...		− 7	9	−5	6	2	3	
VII. 30	...		− 9	9	−5	9	4	0	
VIII. 0	...		−10	9	−5	5	5	4	
VIII. 30	...		−11	5	−4	4	7	1	
IX. 0	...		−12	0	−2	10	9	2	
IX. 30	...		−12	2	−1	6	10	6	
X. 0	...		−11	8	−0	4	11	4	
X. 30	...		− 8	3	+0	9	9	0	The Birth of the Bore.
XI. 0	− 9	0	− 1	9	+1	11	3	8	
XI. 30	− 9	0	+ 3	0	+2	10	0	2	
Noon.	− 9	6	+ 5	1	+3	7	1	6	Pressure at Rambler I. removed.
P.M.									
O. 3	−10	0	+ 7	1	+4	2	2	11	
I. 0	−10	0	+ 8	0	+4	4	3	8	I. 10 Bore passed Haining.
I. 30	+ 3	0	+ 9	3	+4	4	4	11	
II. 0	...		+10	2	+3	11	6	3	
II. 30	...		+10	5	+3	3	7	2	
III. 0	...		+10	3	+2	4	7	11	
III. 30	+ 9	0	+ 9	7	+1	0	8	7	
IV. 0	+ 9	0	+ 8	1	0	0	8	1	
IV. 30	+ 8	6	+ 5	7	−0	10	6	5	
V. 0	...		+ 2	10	−1	10	4	8	
V. 30	...		+ 0	9	−2	10	3	7	
VI. 0	0	0	− 1	7	−3	6	5	1	
VI. 30	...		− 4	3	−4	4	0	1	
VII. 0	...		− 6	7	−4	10	1	9	
VII. 30			− 8	8	−5	4	3	4	
VIII. 0	...		−10	3	−5	4	4	11	
VIII. 30	...		−11	2	−4	10	6	4	
IX. 0	...		−11	7	−3	2	8	5	
IX. 30	...		−11	9	−1	9	10	0	
X. 0	...		−11	6	−0	9	10	9	
X. 30	...		− 9	4	+0	3	9	7	Birth of the Bore.
XI. 0	...		− 3	7	+1	8	5	3	
XI. 30	...		+ 1	11	+2	10	0	11	
Midnight	− 9	0	+ 5	1	+3	6	1	7	Pressure at Rambler I. removed.

APPENDIX C.

PROOFS OF THE SPEED, AND EVIDENCE ON WHICH THE HEIGHTS OF THE DIFFERENT BORES WERE ESTIMATED

SPEED.



A base AB, 821 feet was measured in a direction perpendicular to the general direction of the Bore. Observers at P and C, having the line between them through A and rectangular to AB, observed the angles APB, ACB, thus obtaining AP = 3463 feet

AC = 4326 „

Total length of base CP = 7789 „

Three observers with chronometers were stationed at C, A, and P. C and P had the telescopes of their theodolites parallel and at right angles to the line CAP. Observer at A had previously walked to B and selected an object on the opposite bank of the river in line with A. As the Bore passed, observers at C and P took the time when the left extreme of the foot of the cascade passed the wire of his theodolite. Observer at A took the same phase passed the object he had chosen.

Result :—M.T. place.

		H.	M.	s.
Bore passed C	...	1	21	50
„ „ A	...	1	25	15
„ „ P	...	1	27	54

This gave the speed as observed between C and P ......12·71 knots.
" " " " C " A ......12·53 "
" " " " A " P ......12·90 "

It will be seen that 2½ hours elapses from the time of sudden rise at Rambler island to the time Bore passes Haining. The distance is 29 miles.

Also that 1 h. 7 m. elapsed between the Bore passing Haining and a position on the sea wall 15 miles to the south-west of Haining.

The following account of a Bore, by the Bishop of Mid-China gives an idea of its speed as it proceeds up the river :—

"I felt the sudden rush of the tide at about 5 or 6 a.m., (but
" cannot be certain to half an hour either way) on May 29th,
" this year, 1888, (4 days after full moon) at a place about 100 li
" above Hang-chau, a little short of Tsien-shan (a picturesquely
" placed town 107 li from Hang-chow, called from a striking pyramid
" hill round which the river makes a sharp bend, and just above
" which it is spanned by a bridge of boats). We were sculling and
" towing when the trackers were suddenly called to come on board
" and had only just time to do so when a smooth wave (perhaps 2
" feet above the previous level) came swiftly up and took us up
" stream at a great pace—I should say full 5 miles an hour.
" Unhappily I have no detailed memoranda of the exact spot,
" but the 100 li, which the boatmen gave me in answer to my
" immediate question, 'How far are we from Hang-chau?' places
" it between Lingp'u, a busy town 89 li, and the above-named
" Tsien-shan, 107 li, from Hang-chau.

(Signed) G. E. MOULE."

I think it may be fairly assumed that the Bishop was about 40 miles from Haining. On the night of the 28th May the Bore might have been a little early, but it is out of reason that it could have passed Haining before 1.30. It was high water at Changtau harbour at 5 minutes after midnight; and under ordinary circumstances the Bore passes Haining 1h. 46m. after it is high water at Changtau.

This gives an average speed of about 10 knots between Haining and the spot where the Bishop observed the Bore.

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[*] This was probably a good Bore, as full moon corresponded nearly with Perigee. On the 26th and 27th May the range of tide at Changtau harbour was 13 feet—one foot more than ordinary springs. On the night of 28th, however, the range was not extraordinary; but the high water was early.

HEIGHT.

20 September Night Bore.

A boat grounded at mean level, which is 9½ feet above low water, obtained a sounding of 9 feet, 15 minutes after the Bore passed. The boat drew 3 feet water. This makes a hight of 15½ feet. By subsequeut observations, it was found that 15 minutes after a Bore had passed—at spring tide—the water had risen 3 to 4 feet higher than it was immediately after the cascade had gone by. This would make the height of this Bore 10 to 11 feet.

21 September Day Bore.

An observer in a steam cutter aground at high water on the south bank of the river opposite Haining, eye about 3 feet above high water spring tide, saw the top of the Bore in line with keels of junks on the shelter abreast of Bhota Pagoda. The keel of a junk is 7½ feet above the low line at springs, and the highest part of the Bore is distant from junk about 4 cables. Junk from observer 2·3 miles. Height of Bore 9 feet.

22 September Day Bore.

An observer at base station C, 5 feet above high water spring tide observed the depression of the top of Bore to be 0° 4′ 50″. Depression to top of sea wall 0° 1′ 0″. Distance of sea wall (approximate) 3 miles. Distance of top of Bore (approximate) 2·4 miles. Sea wall about 24 feet above low water ordinary spring tide.

An observer at base station A with eye level with high water spring tide, considered the height of the Bore to be three-quarters that of the sea wall opposite.

An observer at base station P, eye level with high water spring tide; considered that a man on the sands was two-thirds as high as the Bore. The man was of average height, and 1½ miles distant. Bore, as before, 2·4 miles.

The same observer could distinguish no difference in level, when looking through the telescope of his theodolite, between the top of the sea wall opposite, and the disturbed water on the back of the Bore.

Bore 10 to 11 feet.

22 September Night Bore.

Lieutenant Purey-Cust, who was on a junk shelter one-third of a mile west of the Pagoda at Haining, notes: "The side wave as it "struck the embankment was not more than from 4 to 5 feet high, "and the real wave outside apparently 8 to 10 feet. In about "3 minutes the tide rose 10 feet (probably the rapid rise was until "level with the real wave outside)." Bore 8 to 10 feet.

NEW MOON.

4 October. Day Bore. The side of the cascade washed the top of the piles, which, at that time, were 5½ feet above the level of the river. That part of the cascade which was over the deep channel appeared to be higher. Bore 5 to 6 feet.

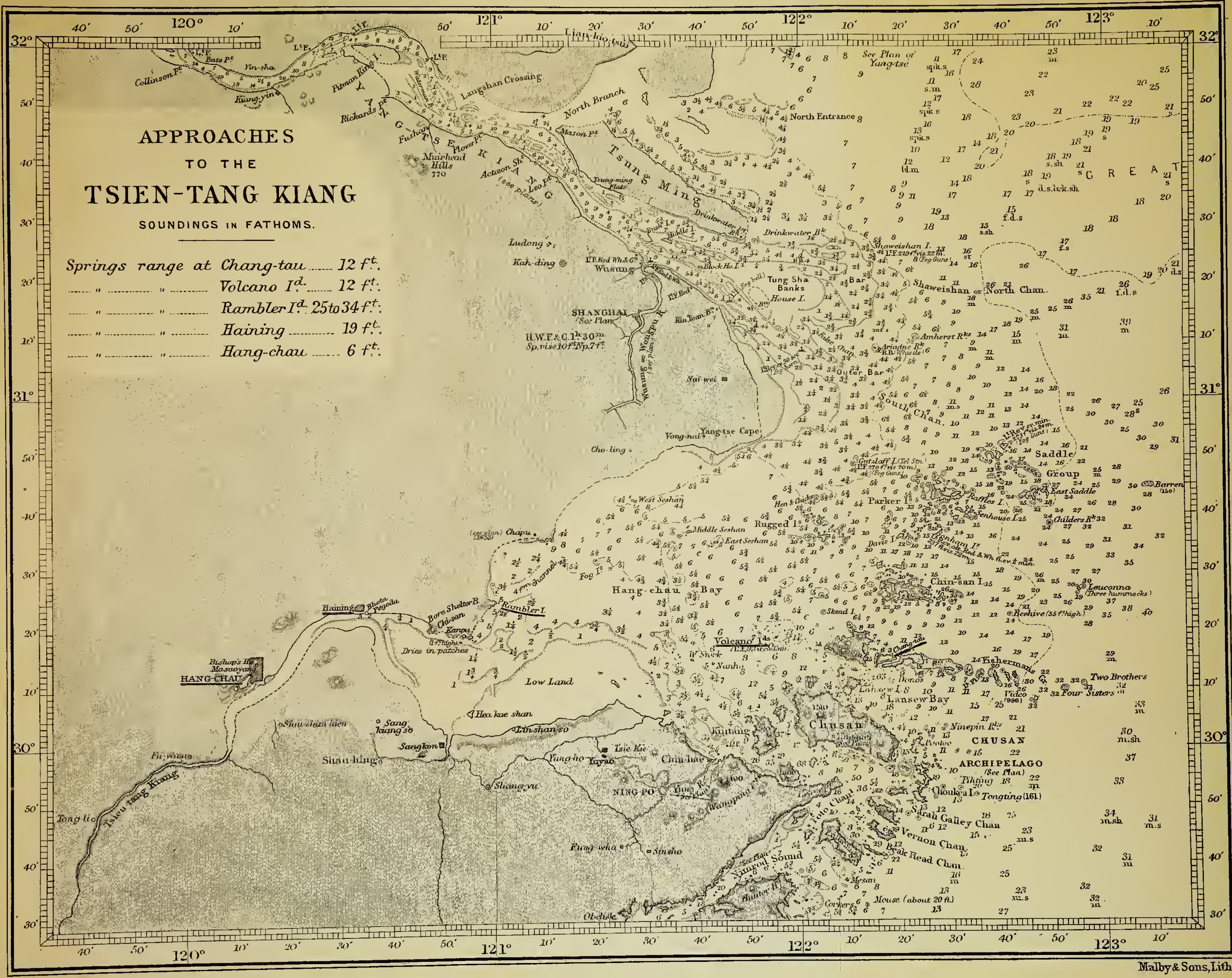
5 October. Day Bore. Side of cascade level with top of piles, which, at that time, were 7 feet above the level of the river. Part of cascade over deep channel higher. Five minutes after Bore passed, the junks on the shelter moved. It required 9 feet water to move the junks. Estimated that the crest of the cascade must have been nearly as high as the level of the water five minutes after it had passed. Bore 8 feet.

5 October. Night Bore. Side of cascade passed level with top of piles, which were 7 feet above the level of the river, and half a minute afterwards water was up to bottom of wall. In 3 minutes junks were afloat, and surging against wall. It required 9 feet water to float junks. Height of cascade over the deep water probably two feet higher than at the side. Considered that, on this occasion, crest of cascade on passing should be registered as high as the water at the wall 3 minutes later. Bore 9 feet.

6 October. Day Bore. Top of piles hidden by the side of the cascade, and junks afloat 2 minutes later. Considered that the crest on passing was as high as the water at the wall 2 minutes later. Bore 9 feet.

6 October. Night Bore. Side of the cascade swept over the piles and up to the bottom of wall, which was 7½ feet above level of river at the time. No junk in the berth abreast the Pagoda. In 7 minutes the water rose to 13 feet. Considered that the crest of the Bore must have been 2 or 3 feet higher than the side at the wall. Bore 10 feet.

7 October. Day Bore. Side of Bore floated the junks at once, which required 9 feet water above the level of the river at the time. Crest about 2 feet higher than side of cascade. Bore 10 to 11 feet.



APPROACHES
TO THE
TSIEN-TANG KIANG

SOUNDINGS IN FATHOMS.

Springs range at Chang-tau ...... 12 ft.
" " Volcano Id. ...... 12 ft.
" " Rambler Id. 25 to 34 ft.
" " Haining ...... 19 ft.
" " Hang-chau ...... 6 ft.

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